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Vol. 13
no. 4

Water Conservation and Drainage

Irrigation

WORLD CROPS

The International Journal of Agriculture

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APRIL 1961

SEVIN Sprayable Insecticide can now be sprayed from the air on many world crops. *For further details, see page* 126

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The International Journal of Agriculture

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Editorial Comment

Key to the Future

SURPLUS FOOD can be moved from one country to another, but surplus water is not so easy to distribute. Although the world's reserves of water might appear to be inexhaustible, water may well prove to be the real limiting factor in population growth, and a major cause of dispute between nations, and between the conflicting interests of town and country, and of industry and agriculture.

We can recall the legal battle between California and Arizona over the allocation of the water of the Colorado River between the two states; the serious dispute between India and Pakistan over the waters of the Indus; and more recently the furore over the Israeli proposal to divert some water from the River Jordan to irrigate the arid Negev.

Demand for water can be expected to rise sharply in the next few years. Population growth and industrial expansion taken together could represent an annual increment in demand for water of, say, 10% and, in addition, the need for supplementary water for use in farms and market gardens, where the rainfall is erratic, is being increasingly felt as the cry for higher productivity from the land becomes more insistent. As more and more desert land is irrigated, new towns and cities will develop and new industries will call for more and still more water from an already overstrained water economy.

Wherever water is in short supply and increased supplies of food are vital the careful conservation and planned distribution of the available supplies of water, the prevention of evaporation and seepage losses and the most effective utilisation of his ration of water by the individual farmer are essentials of good government.

The carriage of irrigation waters in open aqueducts is wasteful on account of evaporation losses and in earth canals can lead to further losses by seepage and land spoilage through salination caused by hydrostatic pressure. The prevention of such losses in the hot arid regions of the world can be so urgent an issue that almost any expense is justified.

Aluminium—now in ample supply, but a rare metal only 60 years ago—is making possible the utmost economy in the use of water on farm and market garden by the use of interlocking piping to replace open canals and drains, and of portable sprinkler units to provide a system of artificial rain which is far more effective and economical than the antiquated system of ditch irrigation which cannot distribute water evenly and without wasting most of it through seepage and evaporation.

Ever-Worsening Situation

HERE IN OVER-POPULATED BRITAIN the water situation is steadily worsening as the population grows, and in the driest part of the country—East Anglia—there is constant dispute over riparian rights as between the agricultural and horticultural communities on the one hand and industrial and domestic consumers on the other.

According to the 'Hydrological Survey of the River Great Ouse Basin',* it is predicted that the Great Ouse—a river which flows into the Wash—could in 11 years' time be sucked dry in a dry summer if consumption goes on increasing at the present rate. This ominous conclusion cannot be lightly dismissed, for East Anglia is the 'bread-basket of Britain'.

The area of the basin is about 3,000 square miles and the survey estimates that in 1959 there were 381 irrigation installations which were known to be taking water from this river or its tributaries. Yet these units irrigated only about 17,000 acres in all out of a total irrigable area of 840,000 acres, which is roughly 40% of the area of the whole river basin. This comprises 80,000 acres of vegetables, 220,000 acres of farm crops, 540,000 acres under grass and 200 acres under glass.

The report suggests that a realistic estimate of the maximum area which could be irrigated is only 10% of the above total, or 84,000 acres, while the apparent rate of increase of water usage is 15%. Thus in five years' time the supply position could well be intolerable.

What is to be done? One suggestion is to bring water from the western hills, where the rainfall is heavier and more uniform, to the eastern counties, where the rainfall is lighter and more uncertain. Such a proposal was actually made at the last Cambridge Irrigation Conference by J. F. Powall, a civil engineer, who has worked on irrigation projects in the Sudan.

A Grand Contour Canal

Briefly, the scheme is to establish a national water grid by a system of arterial waterways, with feeder canals bringing water from the hills and incorporating some already existing canals to convey water in great bulk across country, 200 miles or more, to Lincolnshire, East Anglia and South-East England. The Grand Contour Canal, according to its proposer, must be a broad waterway—deep enough to float large Continental barges carrying 1,500 tons of goods and broad enough to convey water in immense quantities to irrigate 3,000-4,000 square miles of farmland. The dimensions proposed are 100 ft. wide by 17 ft. deep.

*H.M. Stationery Office, 12s. 6d.

The water would travel slowly, but the actual planned delivery rate envisaged is no less than 2,000 cu. ft. of water per second. This is the equivalent of £54,000 worth of water passing a given point each day. The cost of conveyance is estimated to be around 2*d.* or, say, 10 cents per 1,000 gal., and if storage in the chalk underlying East Anglia is found to be necessary the bulk supply rate, including storage charges, should still be within 1*s.* per 1,000 gal.

No estimate, however, is offered for the capital charges of this most ambitious project—the vast construction work appears to us to be a small item when compared with the compensation which would necessarily have to be paid to the companies owning factories and mines and for the houses and farmlands lying in the path of this proposed contour canal. Then there is the challenge of the arterial road system and the vast railway network of Britain—the cost for many new 100-ft. span bridges and tunnels would be colossal.

Nevertheless, that the proposal should have been made at all by a responsible civil engineer serves to emphasise the seriousness of a situation which is slowly and almost imperceptibly worsening, even in rainy England.

Three Rights

IN AUSTRALIA the agricultural scene is also dominated by the need for water. To those who have visited this vast continent with its 90% of desert there is a startling contrast between the lush pastures of the coastal fringe and the bare sunburnt yellow arid lands of the vast interior.

Full advantage has been taken of the Murray-Darling-Murrumbidgee River system—the only major river system in this vast continent—to irrigate a very small part of these arid areas, and water is even being brought from another watershed by tunnelling through the Blue Mountains. This impressive project, which is known as the Snowy River Scheme, will, when completed, add nearly 2 million acre-feet of water to the available supplies.

As the capital value of these once useless lands grows, more and more people will be attracted to the area and the overall demand for water will naturally increase. It will be increasingly necessary for the individual farmer-consumer to apply the right amount of water at the right time and in the right way—which is by controlled artificial irrigation.

Peace Hath Her Victories . . .

MONDAY 19 SEPTEMBER, was a date of great significance to the teeming millions of India and Pakistan, for it marked the end of the 'War of the Waters'. The signing of the Indus Water Treaty provides for the division of the waters of the Indus between the two countries and for the establishment of vast irrigation works.

The treaty provides that the waters of the three eastern rivers in the Indus system—the Ravi, Beas and Sutlej—shall be allocated to India and the waters of the three western rivers—the Indus, Jhelum and Chenab—shall be allocated to Pakistan.

The area of land suitable for irrigation in the Indus basin totals 100 million acres, which we estimate is more than one and a half times the area of the U.K. The average annual discharge of the Indus River system is estimated to be more than twice that of the River Nile, while several of the link canals that will have to be constructed will have a flow of water 10 times as great as that of the Thames above London.

The cost of the plan will be £357 millions, which is to be provided by the International Bank through contributions from eight countries—money far, far better employed than in making inter-continental missiles and inter-stellar rockets. This stupendous project indeed represents a positive contribution to the cause of world peace and all concerned are to be congratulated on the successful outcome of these prolonged and difficult negotiations.

. . . No Less Renowned than War

In the romantic language of warriors, 'the Arabs are preparing to die for the Jordan', according to a recent report in the London *Daily Telegraph*. This is war in the tradition of Indian savages fighting over their hunting grounds in a country where now there is more than enough food for a hundred million people; it is also in the tradition of the fierce tribal wars over pastures . . . and look at what Kenya, Rhodesia and Tanganyika are today.

According to the correspondent, Robin Stafford, Israel is planning to divert some of the waters of the River Jordan to irrigate a small part of the desert area in the Negev, south of Beersheba, and this report is confirmed by the article by C. H. Brown which appears in this issue.

He also reports that Foreign Ministers of the Arab League countries have decided that Israel must not be allowed to finish her plans, which would take vital water supplies from the desert kingdom of Jordan. After centuries of neglect the Arabs now say that they too have a plan to divert the waters of the Jordan.

Israel is building a giant pipeline 5 ft. in diameter from Beersheba northwards to a point between the Sea of Galilee and Lake Hula, where they hope to tap the Jordan. There is, however, at this point a 400-yd. demilitarised zone down both sides of the river, which was imposed by UNO after the 1948 Arab-Israeli war. Now the Arabs are again preparing for war to keep the Israelis out.

So the issue will be joined, and what is the solution? Again, as in the case of the Indus dispute, it is to be found in compromise, for the amount of water that can pass through a 5-ft. main is less than one-hundredth

of the amount that could pass along the Grand Contour Canal that has been proposed for England. It would, indeed, represent only a fraction of the water passing down the River Jordan. The answer is to live and let live and to take an active part in the proper management of the available water by setting up a joint Arab-Israeli Water Board in the same way as the Pakistanis and Indians have settled their dispute. 'Peace hath her victories, no less renowned than war'.

Water and Nitrogen

THAT MAXIMUM GRASS PRODUCTION demands a plentiful supply of water was the not unexpected result of a two-year study at Jealotts Hill Research Station. The purpose of this work, however, was to determine the point at which, as the soil dries out, pasture plants show a marked slow-down in growth. This must be somewhere between field capacity and the wilting point, and the answer to this question should give us a valuable guide as to (*a*) when to irrigate and (*b*) how much water to apply.

The experiments were carried out on established leys with plots at four levels of irrigation, with one plot only rain-fed; the effect of two levels of nitrogen and no nitrogen was also studied. The results showed how irrigation, starting when the soil deficit had reached 0.67 in., gave an additional yield over the non-irrigated plots of 18.6 cwt. of dry matter per acre, when no nitrogen was applied.

However, when nitrogen was used, the effect of irrigation was not so great. Though still substantial compared with the yields obtained without irrigation, the effect of allowing the deficit to grow before irrigating was not so serious when greater quantities of nitrogen were used as it was when nitrogen was absent.

Nevertheless, with the highest rate of nitrogen application, clover did not grow well and the work has established that white clover could compete more vigorously with the grasses as the frequency of irrigation was increased.

Legumes and Nodulation

IN THE ABSENCE OF an acceptable strain of *Rhizobium* bacteria, nitrogen-producing nodules do not form from the roots of a legume. Practical difficulties in establishing legumes have often been overcome by obtaining an appropriate strain of nodule bacteria from the original home of the plant. It may be necessary to inoculate the soil with the bacteria before the crop is planted, either by treating seed with a culture of the organism or by spreading on the field soil taken from a cultivated area where the crop has been successfully grown.

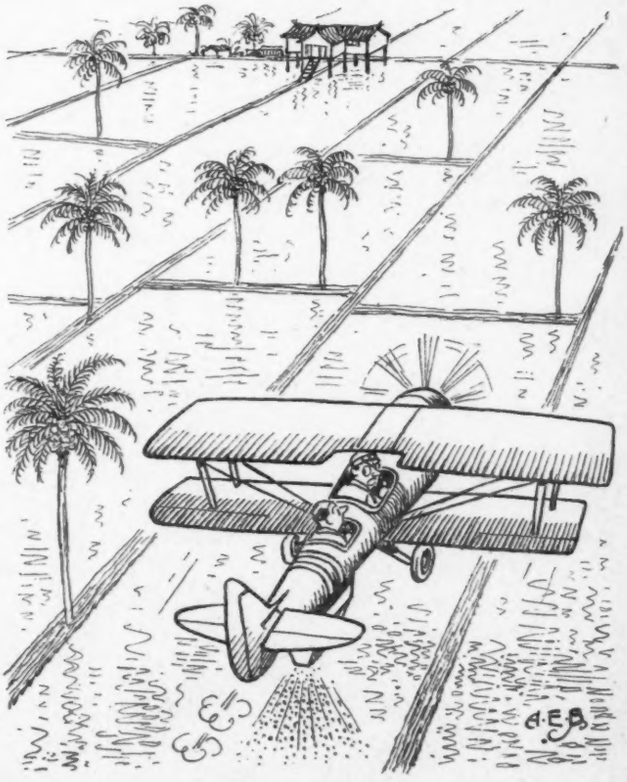
Early introductions into Queensland of many legumes failed because the specific bacteria had not been brought with the plants from their countries of origin. Thus, for instance, the potentially valuable species, *Lotononis bainesii*, was unsuccessful in Queensland until Dr. D. O. Norris successfully extended his search for an effective inoculum to South Africa, where the variety originated.

Another example is provided by the tropical forest tree, *Leucaena glauca*, which made poor growth when introduced into Queensland until bacterial strains of *Rhizobium* isolated from nodules collected in Indonesia and New Britain were used. Similarly, two species of clover, *Trifolium ruepellianum* and *T. semipilosum*, introduced from the high mountains of Central Africa to Queensland, failed to nodulate until inoculated with strains of *Rhizobium* from the African mountains.

From Malaya we read of the successful establishment of cover crops on rubber estates. The Rubber Research Institute of Malaya state that demand for *Rhizobium* culture in that country is about 12,000 packets a year, sufficient for an annual planting of some 50,000 acres of inoculated seed. Most of the culture supplied is of the strain developed for the nitrogenous covers—*Centrosema pubescens*, *Pueraria phaseoloides* and *Calopogonium mucunoides*—but the same culture can be used for certain other legumes.

Biology of Tropical Soils

According to *Rural Research* in C.S.I.R.O., Dr. Norris has advanced a new theory to account for the behaviour of both temperate and tropical groups of *Rhizobium*. He suggests that the Leguminosae, with

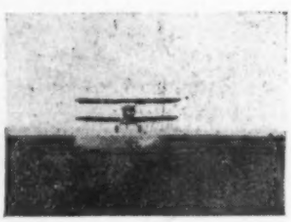


'We're out of juice!'

their associated nodule bacteria, originated in the tropics, to which more than two-thirds of all the legume genera are still confined. The legumes became more specialised as they spread to temperate regions. Finally, genera such as *Trifolium* and *Medicago* emerged which have bacterial requirements that can be met only by a relatively few highly specialised strains of *Rhizobium*.

This theory calls for a radical reappraisal of our ideas concerning the so-called cross-inoculation groups within the *Rhizobium* genus. The original primitive unspecialised tropical legumes would be expected to be adapted to a wide range of *Rhizobium* strains. As evolution proceeded towards more specialised plant genera adapted to temperate conditions, their needs became more specific and could be met only by correspondingly specialised strains of the bacteria. Tropical and sub-tropical legumes do, in fact, maintain to a marked degree the primitive condition of adaptation to a wide range of *Rhizobium* strains. Species such as *Lotononis bainesii* are important exceptions.

Principles applicable to temperate conditions do not always apply in the tropics and as research on tropical legumes has been very limited there is no pool of basic scientific knowledge from which to draw. This situation is being met at the Cunningham Laboratory by the development of an entirely new approach to the root nodule problems of tropical species (see also WORLD CROPS, 1959, **11**, 325).



This Month's Cover Picture

A new formulation of 'Sevin' insecticide, called 'Sevin Sprayable', is a finely ground powder for use in aqueous suspension in ground or aerial applications. Where large areas have to be sprayed aerially in a single trip, 1 lb. of this insecticide can be applied in as little as 2 gal. of water per acre.

This method of treatment of grain and forage crops is rapidly growing. Recent trials in the U.S.A. have shown that livestock can be given forage treated with 'Sevin Sprayable' up to seven days before harvesting without any fear of contaminating the meat or milk. This would indicate that the material is completely broken down in the animals' digestive systems and the products are passed off.

The combination of effective insect control and safety in use to man and animals makes 'Sevin' a valuable weapon of modern agriculture.

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Advertiser's announcement

Power to Compete

THIS WAS the theme of the 10th National Power Farming Conference held at Brighton last month. In his invigorating opening address Mr. J. M. A. Smith, assistant managing director of the *Ford Motor Co.*, defined this as power to plan and to organise agriculture and power to replace labour which in every high-wage country was tending to leave the land.

Competition, he said, was the keynote of the Free World—something which we can meet and enjoy. Britain must be prepared to meet, compete with and beat the products of other countries, anywhere and everywhere in the world.

There is only one way to compete—to provide only what the consumer wants, offer it at an attractive price and market it efficiently. All this, we think, might appear to be obvious—but it is sometimes overlooked or forgotten.

For farmers 'power to compete' meant not only power in the literal sense—tractors and engines to do the work of horses—it also means power in the sense of ability—the all-round re-equipment of farms and the readjustment of age-old ideas, to reconcile high wages with low production costs and to produce more and still more food.

Power for Potatoes

POTATOES ARE a highly vulnerable crop, as the article in the March issue by W. H. Cashmore, Director of the N.I.A.E. emphasises.

The efficient and proper use of the tractor and its wide range of auxiliary implements has enabled the potato grower to do considerably more in his cultivation than was ever done by men and horses.

Land can now be ploughed early, when necessary, spring cultivations can be done at short notice at the best possible time and mechanised harvesters and lifters are becoming increasingly more efficient and capable of coping with different conditions—but there are snags in all this.

Mr. J. Arbuckle, a Scottish farmer who is a member of the Potato Marketing Board for Central Scotland, said at the Power Farming Conference that future developments in farming practice must be towards the elimination of clods and design towards preventing clod-forming actions by implements.

Also, one of the major problems of agricultural engineers is to design machines which will lift potatoes efficiently giving reasonable separation from stones and soil—but at the same time with the minimum of damage to the tubers.

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A portable hand-move sprinkler lateral operating over potatoes in the Columbia basin area of Washington state. The sprinklers are spaced 40 ft. apart and the lateral is moved 60 ft. every 12 hours, applying the equivalent of 3.5 in. of water over the field every seven days

*Sprinkler Irrigation in the U.S.A.**

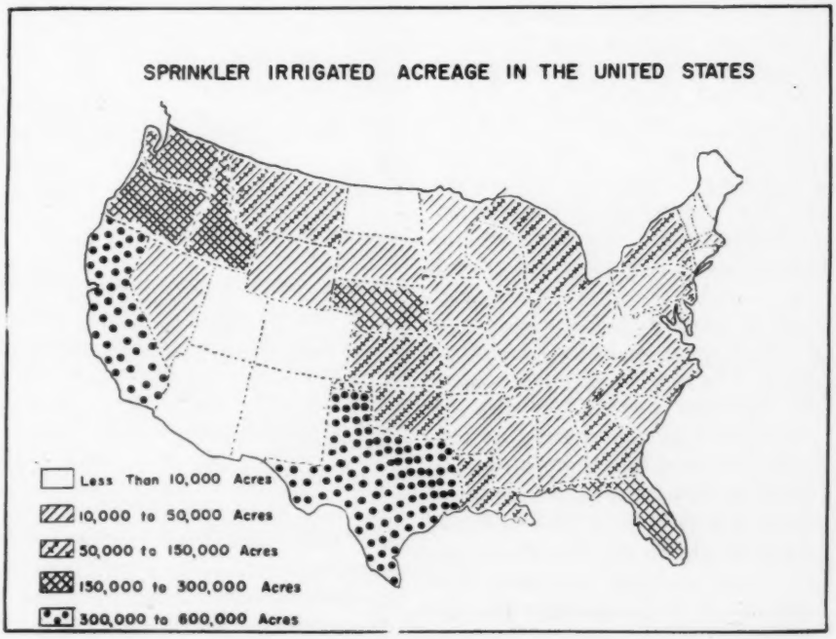
C. H. PAIR†

Sprinkler irrigation in the U.S.A. had its beginnings on the lawns and parks in and around the cities; in the early 1900s it was taken up by the nurserymen, market gardeners and fruit growers of the eastern states; the twenties saw a further extension of this type of irrigation to the orchards and vineyards of California and other western states; but the biggest development has taken place in agriculture since the end of the last war.

THE traveller in America can now see spray sprinklers at work in the cotton fields and vineyards of California, the fruit orchards and grain fields of Washington, the market gardens and citrus groves of Florida, and the potato fields of Maine. Between these areas sugar-beet, alfalfa, tobacco, soft fruits, maize and pasture crops are also sprinkler irrigated.

Early stationary systems

The first agricultural sprinkler system consisted of a few lengths of steel pipe supported on parallel rows of posts and connected to a hand pump. A series of small holes were drilled in the shell of the pipe through which water was forced to produce the spray. These small holes gradually became


SPRINKLER IRRIGATED ACREAGE IN THE UNITED STATES
Less Than 10,000 Acres
10,000 to 50,000 Acres
50,000 to 150,000 Acres
150,000 to 300,000 Acres
300,000 to 600,000 Acres

* Contribution from Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, in co-operation with the Idaho Agricultural Experiment Station.

† Irrigation engineer, Western Soil and Water Management Research Branch, Soil and Water Conservation Research Division, Agricultural Research Service, U.S. Department of Agriculture, Boise, Idaho.

Spray from a solid sprinkler system. This system has enough laterals to irrigate a field without disconnecting and moving the piping

clogged or irregular in shape due to rusting of the metal pipe.

This was corrected by replacing the small holes with brass nozzles which were screwed into the pipe shell and would not rust. In order to spread the cost of such equipment over a greater irrigated acreage, these pipelines with their brass nozzles were mounted in bearings on top of posts and the pipe was rotated through 90°, thus covering a larger area. Most of these installations represented an investment of $300-$500 per acre.‡

Portable systems arrive

This stationary sprinkler system gave way in the 1930s to a portable system of lightweight steel pipe connected by quick couplers. This completely changed the picture of sprinkling as a method of irrigation. The main consideration with the stationary systems was the initial cost: the capital investment with the portable system was only about 10% of that required by the old stationary system. The expense of operation now became an important item, as sometimes this annual cost exceeded the capital investment in equipment. The new portable systems were better adapted to, and used more, on field, pasture and truck crops, such as sugar-beet.

During World War II, aluminium production was greatly expanded in the U.S.A. and this subsequently made it necessary to find a new market for aluminium products. Lightweight aluminium piping and quick couplers for sprinkler systems provided one new market for aluminium. Sprinkler irrigation provided an easy method for bringing new lands rapidly into production to meet the post-war demand for food and fibres. The result was a tremendous expansion in the acreage covered by hand-move, portable, sprinkler systems during the 1946-56 decade.

Sprinkler acreages

The 1950 Census of Agriculture included a question on the extent of irrigated acreage that was sprinkled. It was found that a total of 639,987 acres were sprinkler-irrigated during 1949 and this total increased to 3.06 million acres in 1955. *Irrigation Engineering and Maintenance* magazine has reported a total sprinkler-irrigated acreage of 3.65 million acres for 1959.

The arid western states had 70% of all the sprinklers, while the remaining 30% were used in the humid eastern states. The distribution of sprinkler-irrigated areas by states is shown on the map.

Types of systems

There are now many types of sprinkler systems and accessory equipment used in American farming. The factors of equipment cost, labour requirement and suitability for the particular farming operations determine the type of system used on each farm.

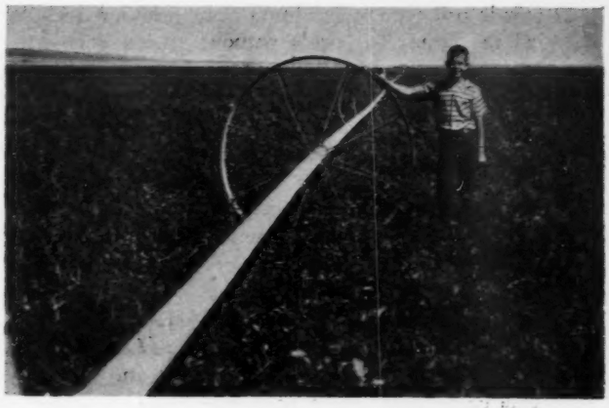
Sprinkler systems have been generally classified as portable, semi-permanent or permanent. This classification depends on whether the lateral pipeline (including sprinklers), main pipeline and pumping plant are movable or fixed.

Permanent systems have buried main and lateral pipelines and a permanently sited pumping plant. Equipment and installation costs per unit of area is higher than that of any other system and ranges from $400-$700 per acre. The labour costs for operation, however, are lower than those of any other system. These systems are used for perennial crops needing full-season irrigation, such as orchards, vineyards and citrus groves, and also in nurseries and a few permanent pastures.

A self-balancing sprinkler head which remains in the vertical operating position irrespective of the position of the branch from the lateral pipe

Semi-permanent systems consist of portable lateral pipelines, permanent buried main pipelines and pumping plant. Equipment and installation costs are moderate, ranging from $90-$175 per acre. Operating labour requirements are moderate, averaging

‡ U.S. $3 = £1 sterling = Rs. 13 = Straits $8 (approx.).



Left: *The powered unit of a side-roll sprinkler lateral showing 1½-h.p. petrol motor and reduction gears. This unit is placed at the centre point of the lateral.* Right: *A side-roll wheel-mounted lateral, 1,300 ft. in length, in a potato field. The aluminium pipe is 4 in. in dia.; the wheels are 58 in. in dia. and spaced 40 ft. on the pipeline*

about one man-hour per acre for each irrigation. These systems are found in areas needing full-season irrigation and on farms having permanent field boundaries and are the most widely used systems in the country.

Portable sprinkler systems have portable pipelines, usually aluminium, from the pumping plant to the last sprinkler lateral. The pumping plant may be either fixed or movable, although in a completely portable system the pump and all the piping would be portable. Portable systems have the lowest unit of area cost—from $60-$125 per acre—for equipment and installation. Labour requirements for operating are, however, higher than for either permanent or semi-permanent installations. Portable systems are found wherever sprinklers are used. They are well suited for occasional or supplemental irrigation and predominate on farms in the humid areas of the eastern states.

Sprinkler system mechanisation

In one generation food production in the U.S.A. has progressed from a maximum use of manual labour to a maximum effort in mechanisation. Today the use of petrol and diesel tractors, with their accompanying farm implements, permits one man to do the work of five men or more on the farm. There is not yet complete automation in planting and harvesting, but much has been achieved. With the mechanisation of so many farm operations, many farmers are now looking at their portable and semi-portable types of sprinkler systems with their hand-move laterals with a view to reducing the amount of labour needed for irrigating their crops.

This has resulted in manufacturers developing side-roll and pull-type wheel systems, drag, giant-sprinkler, self-propelled and solid systems. These labour-saving developments increased initial equipment costs and work best on level or uniformly sloping fields.

A portable motor-powered centrifugal pump used to deliver water from a pond under pressure into a sprinkler system. The hand pump directly above the centrifugal pump is used for priming. The starting equipment is on the short post and the overload relay, fuse box and electric meter are located on the taller pole

The side-roll system

The most widely used mechanical sprinkler system today is the side-roll, in which the sprinkler lateral pipe is used as an axle. Wheels, varying from 4-7 ft. in dia., are mounted on this pipe axle. Hand or, more recently, power-driven devices are utilised to move the sprinkler lateral from one setting to the next across the field. The laterals are equipped with automatic drain valves that drain the pipeline when the pressure is shut off. In windy areas braking devices are installed on each lateral to prevent damage to the pipeline by wind blowing it across the field when the lateral is empty of water.

One farmer in the state of Washington had a quarter of a mile of side-roll sprinkler lateral moved a half mile by wind action. To facilitate making connections to the main pipelines after a move, special quick-coupling telescoping pipe sections have been developed at the end of the lateral.

The side-roll type of system is best adapted to rectangular fields without obstructions and having fairly uniform topography. It is used on wheat, potato, sugar-beet, alfalfa and similar close-growing small grain, row and forage crops.

The first systems of the side-roll type were hand-move sprinkler laterals with wheels clamped on the pipe every 30-40 ft. There was considerable leakage of water from the couplers and sag due to the weight of water in the pipeline. This caused alignment problems after each lateral move, requiring extra labour to line up sprinklers properly after repositioning a side-roll lateral, especially on rolling land. The leakage and alignment problems have been solved by the introduction of special reinforced couplers, counter-balanced sprinkler heads that remain upright regardless of the position of the lateral pipelines and heavier pipe.

The standard aluminium pipe wall thickness in a 4-in. wheel-move sprinkler lateral is .072 in., while that of a hand-move system is .050 in. In the Columbia basin area of Washington 4-in., 14 gauge, steel pipe was welded together and the wheels welded to the pipe at 40-ft. intervals to form laterals up to 1,320 ft. in length. These steel laterals are limited in use to sandy and sandy loam types of soils because their weight would cause moving problems in other soil types.

The cost of the side-roll system is from one and a quarter times to twice as much as comparable hand-move systems. The labour used in moving portable laterals is reduced 50-60% over the hand-move lateral system. One farmer, near Grand Coulee Dam in the state of Washington, had exchanged his two quarter-mile hand-move sprinkler laterals for two quarter-mile side-roll sprinkler laterals and when questioned about their operation said: 'The side-roll laterals not only save me half the time I used with the hand-move laterals, but, better still, they save me 90% of the work'.

(*To be continued*)

Letters to the Editor

What is a Cultivar?

Sir,—I was very interested in the editorial paragraph entitled 'What is a Cultivar?' My explanation would be as follows:

A cultivar is often miscalled a variety that has arisen accidentally or by hybridisation among cultivated plants of the same species. Hence the newly bred rose may be a cultivar; or a 'sport' or even a mutation may be a cultivar—even if it is a form, or mutation of the species, found in a wild state.

A variety differs from a cultivar because it is botanically distinct from other varieties, although it may have varying cultivable forms or cultivars within the limitations of taxonomic botany.

A strain is also varietal, but it must be a mixture of the forms, or cultivars, or selections within a variety, as, for instance, there may be a special strain of polyanthus which contains new and charming colours not necessarily fixed. A blue polyanthus that will breed true from seed, if there is such a thing, would be a cultivar and not a variety, as it used to be called.

If there are two botanical varieties of Arabian coffee, *i.e.* Arabica and Bourbon, many other forms may be found among the wild coffee of Ethiopia, but these forms or mutations arise from one or the other distinct botanical varieties and in the wild state it is better to call these diverging phenotypes, forms rather than cultivars. Hence in cultivation we have varieties, cultivars or forms, and in the wild state we have varieties and forms. Only the variety is the type, so one cannot speak of types.

A. E. HAARER.

[Mr. Haarer, F.L.S., is the author of 'Modern Coffee Production', published by Leonard Hill Ltd., price 56s.]

Overseas Trade

Sir,—May I refer to the report of speeches made at the anniversary dinner of WORLD CROPS, which appears in the February issue of the journal? I have received confirmation from more than one source of your statement that British business is resting on its laurels in the belief that former dependent territories will give it favoured-nation treatment in trade in the future, a most disturbing fact at a time when Britain must increase her exports if she is to compete with other countries in the top flight.

These territories, even though they may remain in the Commonwealth, will not automatically give Britain priority unless she can prove her ability to produce goods on time, at competitive prices and suitable to the needs of the countries concerned.

They constitute a most important export market with considerable growth potential and if British business is to benefit it will need to strengthen its export departments with men who know the customs, language and modes of thought of the people of the overseas territories in the same way that it looks for men with knowledge of Europe or America where those are the targets.

In short, successful business not only requires a knowledge of business practice, which can be picked up reasonably quickly, but an intimate knowledge of the requirements of the particular market and, more important still, of the way in which the customer's mind works. Men possessing this knowledge are returning from the Colonial Service in ever-increasing numbers and their valuable experience will be lost unless business takes a speedy interest in them.

Throughout their service abroad, in the field of agriculture, health, public works and administration, they have been selling ideas, often unpalatable ones, which is probably more difficult to do than selling objects, and they have a wealth of knowledge of a very large proportion of the world's area and population. Business should not surely lose this expertise.

R. L. PEEL.

Director,
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A Development Survey in Tripolitania

1—Water Conservation at Tauorga Oasis

S. G. WILLIMOTT, D. W. GILCHRIST SHIRLAW, M. E. FRISBY and J. I. CLARKE*

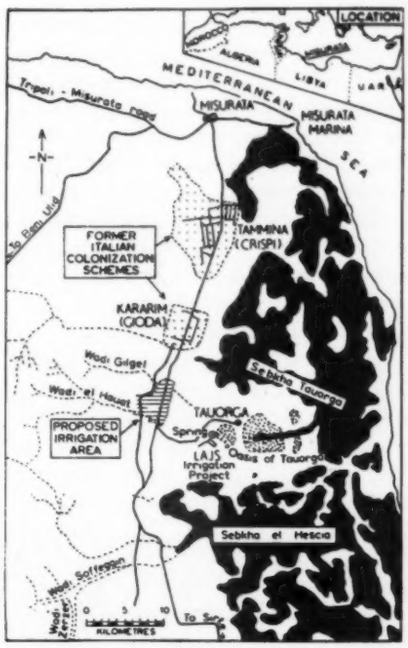
A reconnaissance survey of the Tauorga region of Libya was recently carried out by a team of four from the Durham Colleges of the University of Durham, following an invitation from the Government to Prof. W. B. Fisher, head of the Department of Geography. The object of the survey was to discover areas suitable for development as irrigation projects, based preferably on the water from the Tauorga spring.

THERE can be no doubt that the limiting factor in agricultural development in Tripolitania, as in the whole of the vast desertic country of Libya, is water. In this arid environment, the supply of surface water is both meagre and erratic and it is not surprising that the search for new sources of water and for new methods of conservation of existing supplies has dominated the pattern of development of post-war agriculture.

Water conservation problems

The problems of conservation of surface water are often accentuated by the rapidity of run-off and by intense evaporation during the growing season. Nevertheless, in ancient times the Romans made effective use of dams, weirs and cisterns for water and soil conservation; some of these are still in use today. The Roman irrigation works were necessarily confined to the exploitation of surface water and of wells, but only to a depth of approximately 250 ft.

The Roman storage cistern was mainly used by the sedentary farmer; today great efforts are being made to restore many of these ancient ruined cisterns. But the sedentary agriculturist requires a dependable water supply throughout the year and thus has to rely principally on wells and artesian sources of supply. The development of artesian water supplies was initiated during the Italian regime and has been continued by successive administrations ever since. Springs are not abundant either in number or in potential.



Reconnaissance area south of Misurata in Tripolitania

Irrigation farming

One of the most striking features of Tripolitanian agriculture since the war has been the change from dry to irrigation farming, a development which is still expanding. Irrigation agriculture is almost wholly dependent on the use of semi-artesian and artesian water located in the Quaternary and Miocene formations. The discovery of substantial supplies of artesian water has made possible the intensification of cultivation both in the narrow coastal belt of North Tripolitania and in parts of the Jefara plain to the south.

Together with the Italian farmers, whose numbers continue to decline, some of the former Arab subsistence farmers are now beginning to produce cash crops, such as groundnuts, olive oil and citrus fruits for export. Apart from the potential of the aquifers, a limiting factor in cultivation is high salinity of much of the artesian water available. Nevertheless, in the Misurata district of Eastern Tripolitania brackish water has been successfully utilised on sandy soils of high calcium status and good permeability for about the last 25 years. A variety of salt-tolerant crops, such as barley, oats, olives, figs, onions, beets, tomatoes and lucerne, are cultivated.

South of Misurata, an area traditionally devoted to pastoral nomadism, reliable sedentary agriculture is dependent on irrigation. At present there are only three extensive irrigated areas: Tammina, El Kararim and Tauorga (see map). The first two are former Italian agricultural settlements based on the exploitation of artesian aquifers and producing both tree and field crops. On the other hand, cultivation in the native oasis of Tauorga relies on the flow from a large spring, but is confined to the date palm.

The Italian settlements

Comparison of the two former Italian settlements of Tammina (Crispi) and El Kararim (Gioda) reveals the striking efficiency and diversity of

* This team worked in Libya from 25 August-6 October, 1960, the expedition being financed mainly by funds provided by the Libyan American Joint Services and a grant from the Rockefeller Foundation.

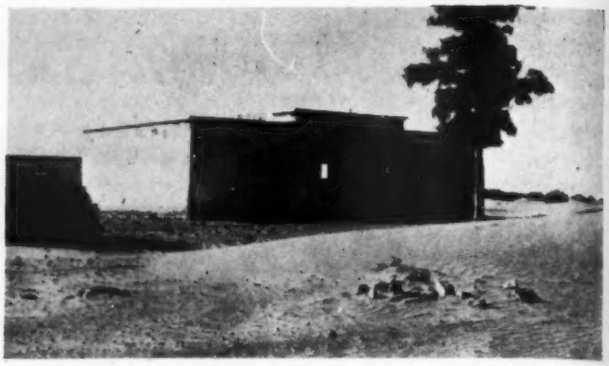


Fig. 1. Left: *An Italian farmstead at Tammina (Crispi) established 25 years ago by the E.N.T.E. demographic colonisation scheme.* Fig. 2. Right: *A derelict Italian farmstead at El Kararim (Gioda) with encroaching sand dunes*

cropping at Tammina in contrast with the neglect and decay at El Kararim (see Figs. 1 and 2). Parts of the Tammina settlement exhibit an impressive adaptation to the environmental conditions. Its soils are chiefly loamy sands of weak structure and of red-brown colour. In both depth and uniformity they are markedly superior to the soils of El Kararim. The depth of soil exceeds 2 m. over much of the area and the homogeneity of soils is remarkable.

Stony soils and sands are restricted to the margins of the area, where they have probably contributed to the failure of many associated farmsteads, especially east of the road. However, inadequate care and maintenance of irrigation works is certainly another important contributing factor. In the marginal areas blown sand frequently occurs on the surface and appears to be increasing in amount as dereliction proceeds. In such localities the soil structure is less developed than in the centre of the settlement, where efficient cultivation has prevailed and the breakdown of the soil into clods on ploughing is marked. Here most of the underground water is of poor quality and too often irrigation canals are choked and ruined.

El Kararim as an irrigation project is also of special interest. The soils are mainly loamy sands, stony and shallow; calcrete underlies most of the area and in parts is found outcropping on the surface. Salinity and alkalinity do not appear to be serious problems, the limiting factor in development being soil depth. Nevertheless, apart from small localities susceptible to improvement, the logical development of most of this area would seem to be in afforestation and controlled grazing.

The Tauorga oasis

The oasis of Tauorga is of special importance because it is watered by a natural spring, probably the largest in Libya (Fig. 3). The remarkable potential of this great spring, which might well serve as the source of supply in any development project, has long attracted the interest of both administrators and agriculturists. This interest culminated in modern times in the inception of an Italian scheme of 1938 designed to irrigate an extensive area of the order of 2,000 ha. (5,000 acres) situated west of the present Misurata-Sirte highway.

Somewhat surprisingly, the actual outflow of the spring still remains unknown. Although there seems little doubt that it fluctuates throughout the year, its capacity has been estimated between 12,000 and 18,000 cu. m. per hour and may be more. At present the spring water forms two small lakes before meandering through the malarial swamps and reed-choked channels of the oasis to be lost in the salt marshes or *sebkh* of the coast.

The water quality is not high, but its salt content does not preclude a consideration of its use for irrigation on selected soils of this region. Probably most of the water under present conditions is lost by evaporation and by seepage. Tauorga oasis could clearly be improved by the reduction and control of surface water flowing from the spring by a well-planned scheme of irrigation and drainage.

The Tauorga spring has sustained a considerable population, though little else, through the centuries. The oasis contains more than 100,000 date palms which support a population of about 11,000 people, mainly of negroid descent. The date is the principal fruit of the country and provides a staple foodstuff as well as the local alcoholic beverage known as *laghbi*, but under Italian colonisation this fruit was not regarded as a crop suitable for development; in the hands of the Libyans it must play an important part in development schemes. It is here that the Tauorga oasis offers considerable scope for such extension, since the saturation point of development of the date has by no means been reached.

Reconnaissance area

In order to discover soils suitable for irrigation in the region a reconnaissance was carried out, extending from Tammina in the north to the Wadi Soffeggin in the south. The whole area can be classified as continental steppe and rainfall diminishes from 200 mm. per annum (8 in.) in the north to less than 150 mm. (6 in.) south of Tauorga. This area consists of an almost flat plain of Quaternary deposits, and slopes gently eastwards to a vast low-lying belt of salt marsh separated from the sea by a much thinner zone of coastal dunes. The true *sebkh* and the coastal dunes were excluded from the reconnaissance area.

Four landscape types are found within this region. First, the plain is traversed by eastward-flowing wadis, which are not outstanding topographic features, but greatly affect the soil mantle. This influence is particularly marked in the southern part of the area examined, where the Wadis Gilgel, El Hauat and Soffeggin have laid down good loamy alluvia greatly prized by local tribesmen for the shifting cultivation of cereals, mainly barley. The lower reaches of the Wadis Gilgel and El Hauat were the subject of detailed

investigation. (*Discussed in Part 2.*)

The second type is associated with the presence of calcrete and is characterised by low rounded hillocks covered with thin stony soils. Calcrete landscapes are dominant in the western part of the reconnaissance area, especially along the interfluves of the wadis.

The third landscape type is composed of sand hummocks of varying height up to 2 m. and capped by halophytic plants. The hummocks are most frequent along the western margin of the salt marshes, between the latter and the calcrete. The associated soils are extremely saline and the water table is high.

The fourth landscape type is the *sebkha* margin. The calcrete areas, the hummocks and the salt marshes are of little value either to pastoralists or to cultivators. All four features of the landscape are clearly delimited by aerial observation.

The Wadi Soffeggin

The Wadi Soffeggin comprises a large system of wadis, draining in a W.S.W.-E.N.E. direction, eventually finding the *sebkh* south of Tauorga. East of the Misurata-Sirte main road the Soffeggin has two courses, but the occurrence of extensive pebble beds precludes the possibility of irrigation.

A similar situation is found to the west of the road, although narrow margins of deep sandy loams were examined along some of the braided channels. A few kilometres further west are broader areas of useful soil which afford important grazing and cultivation for the three main local tribes: Guaddi, Salatna, Meharza. Shallow wells along this relatively populous wadi system could have considerable success in facilitating settlement conditions. However, irrigation from the Tauorga spring is not practicable, as the direct distance over the salt marsh is nearly 18 km.

The calcrete areas

Areas of calcrete are widespread in the western part of the reconnaissance area and their boundaries are usually marked by low scarps. They are characterised by sparse vegetation and their stony soils are of little agricultural value. Between Wadi El Hauat and Wadi Soffeggin the rounded hillocks of calcrete are separated by small and isolated patches of soil of moderate depth (up to 80 cm.) along wadi beds and in small basins, where shifting cultivation of cereals is practised. These patches vary in size from 1-25 ha. and are too restricted for irrigation works. They probably cover less than 10% of the area under consideration.

The hummock areas

Characteristic hummocks are found over extensive areas north and west of Tauorga; they vary in height from a few centimetres to more than 2 m. The hummocks are composed of blown sand, sometimes with a weak structure and capped by bush vegetation. They are generally rather widely scattered and are often separated by surfaces of hardened sand. Only rarely are the hummock areas used for the cultivation of cereals; more often they are used as quarries for indurated building material. Infiltration rates are low and salinity is high. At the same time, clearance of vegetation would immediately pose a problem of drifting sand.

The sebkha margin

Sebkha appears in several phases of development and has been little studied in Libya. True *sebkha* is almost devoid of vegetation and is periodically flooded. Intense evaporation helps to create a salt crust which usually overlies a plastic saline dark grey mud. North and south of Tauorga irregular belts of marginal salt marsh are encountered which are not separated from the true *sebkha* by any well-defined line of demarcation. These areas are generally slightly higher than the true *sebkha* and the groundwater level is slightly lower. They may still be subject to spasmodic inundation.

The underlying saline muds are thinly covered either by light yellow sand crusts and low hummocks (30-45 cm. high) or by a dark red-brown crust devoid of hummocks. Both of these thin and fragile surface layers crumble under foot and accumulations of gypsum are common. The *sebkha* margin is useless for irrigation agriculture for the following reasons: shallow soil depth, high groundwater, periodic flooding, poor drainage, excessive salinity, high alkalinity and the occurrence of curious areas of crustal collapse where holes revealed high groundwater levels.

(*To be continued*)

Fig. 3. *The Tauorga oasis, which is watered by a natural spring, probably the largest in Libya*

World Crops and Overseas Trade

In the caption to the illustration showing guests at the WORLD CROPS Anniversary Dinner, February issue, page 56, the name of Mr. N. G. H. Thomas, of *Monsanto Chemicals*, was included in error for that of Mr. N. E. Williams, of *Burt Boulton and Hayward Ltd.*

Left: *Five pairs of bullocks drag simple ploughs round a piece of paddy land near Madras 6/10 of an acre in extent. Six operations, taking these five pairs three days, will be necessary before a satisfactory puddle can be obtained. The cost is about Rs.30 per acre.*
Right: *A satisfactory puddle can be obtained mechanically at the rate of an acre every 1½ hours and at a cost of Rs.12 per acre*

PROGRESS THROUGH POWER FARMING

2—Achievement of Rational Mechanisation

A. B. P. G. BEHR,* B.SC.(AGRIC.), A.M.I.AGR.E.

India's economic problems are in some ways unique. The scale on which they are being attacked has been unequalled and developments there are of constant interest to all concerned with agriculture or economics. We believe that this article will stimulate discussion about development projects in general, and about the Indian position, at the commencement of the third Indian Five-Year Plan in particular.

THE arguments put forward in Part 1 will have gone a long way towards establishing the need for mechanisation with tractors and implements that already exists in India. The dangers of over-mechanisation are illusory. Firstly, because Indian industry would be incapable of coping with the production of immense numbers of machines necessary to have any harmful effect on the human population. Secondly, because mechanisation at any lower level would, in fact, have many beneficial social effects, which will be considered towards the end of this article.

Possibilities of progress

A formidable number of Indian farmers are in a position today to purchase, and utilise efficiently, mechanical cultivating power. Indeed, demand greatly exceeds the current supply and will continue to do so in the foreseeable future. For this reason extension work devoted to the explanation and promotion of mechanisation has almost come to a standstill.

In addition to private purchase, there are many ways through which farm machinery can be applied to Indian farmland. Already official loans to farmers, State tractor organisations and State mechanised farms make their contribution. Private individuals buy machines for contract use. Great possibilities exist for the development of hire-purchase facilities and for the establishment of farm machinery syndicates.

*Marketing Manager, Tractors and Farm Equipment Private Ltd., India.

Progress through co-operatives

Very great hopes are placed in the formation of State-guided agricultural co-operatives. Such a development could perhaps provide the best chance of extending rational farm mechanisation to the three-quarters of all Indian farmers whose present holdings would probably not justify private tractorisation in one form or another. Unfortunately, much can be said both for and against this farm co-operative policy. Practical results are likely to be limited in number and slow of appearance.

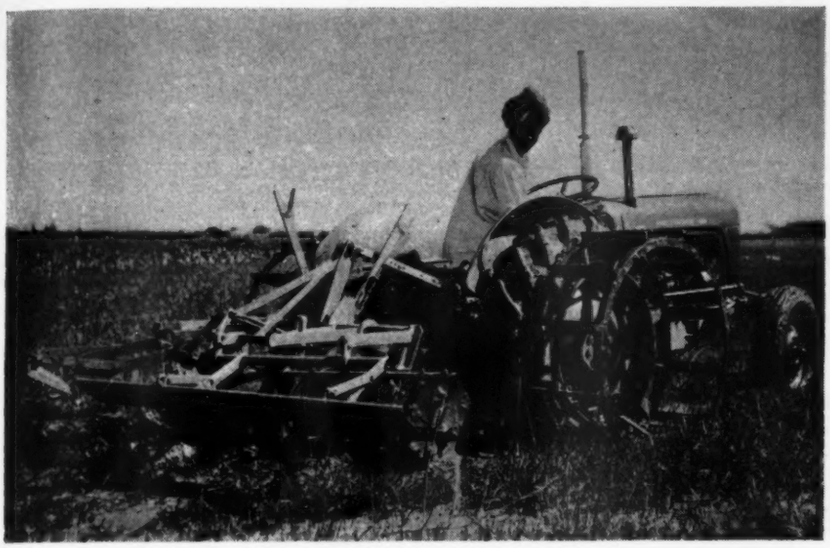
In view of the political adherence to this policy in India, and its bearing on similar aims in other under-developed countries, it is worth while quoting Bauer and Yamey,[7] who point out that:

'The co-operative nature of a society

engaged in business does not guarantee its success or provide it with a special formula for efficiency. . . . From the strictly economic point of view there is no special merit in co-operation, which is merely one form of business organisation. . . . Government assistance, and the promise and expectation of further assistance, undermine the self-reliance of the co-operators. . . . We consider a policy of so-called compulsory co-operation as undesirable and inimical to economic growth'.

absorption so that sufficient quantities can be placed in the hands of Indian farmers, and so that factories can reach economic volumes of production with the least delay.

The lesson here is plain for all under-developed countries—if economic goals demand the introduction of technological improvements, then these must be introduced with a rapidity which will have a significant effect on the achievement of those goals and will ensure minimum unit costs.



A Massey-Ferguson tractor fitted with cage wheels with a puddling implement lifted clear to show details

Mass production essential

Whatever the channel, the effective application of such funds as are available is directly related to the price of farm machinery. As must be the case in all developing countries, India is committed to the domestic production of tractors and implements. This will be undertaken by three factories, producing together a planned total of 10,000 units by 1966.

This quantity is insufficient in relation to food grain production targets. Further, it severely limits manufacturing volumes per factory. The result of this will mean that the Indian farmer (or other purchaser) will pay almost twice as much for a farm tractor made in India as will the far wealthier farmer in the West, where the extreme benefits of mass production are still largely unrecognised by the farming community.

Clearly a grave responsibility faces the Indian Government to do everything possible to stimulate tractor

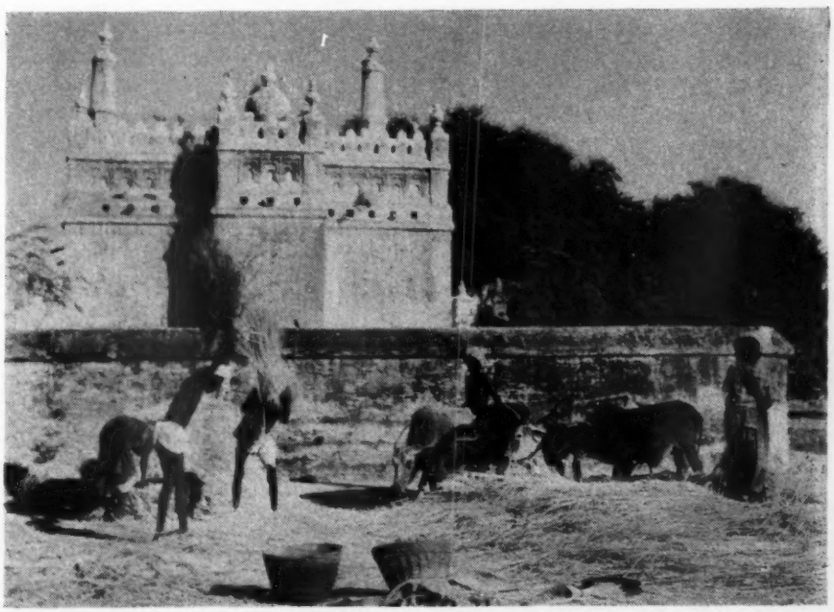
Need for incentives

So far we have emphasised the fundamental need to accept and attain food production targets in India. We have agreed that very large burdens will face the Indian farmer, even if he is fortunate enough to be able to get hold of mechanical cultivating power so as to make good labour and draft animal shortfalls against target.

It is necessary now to examine the extent to which the potentially progressive farmer in India, and indeed in all low-income countries, can be motivated towards the goals assigned to him—goals demanding immense efforts and unremitting forward commitments on his part.

One of the most (if not the most) beneficial effects of increased *per capita* farm productivity arises from the correspondingly increased purchasing power of the farmer. A farmer with money to spend can take an active part in the development of a vigorous national economy.

He becomes a potent consumer of capital goods and equipment. He purchases agricultural raw materials and machinery, the production of which provides important employment in the industrial sector of the community. The extent and profitability of his operations are thereby still further improved. With a larger income he pays more direct and indirect



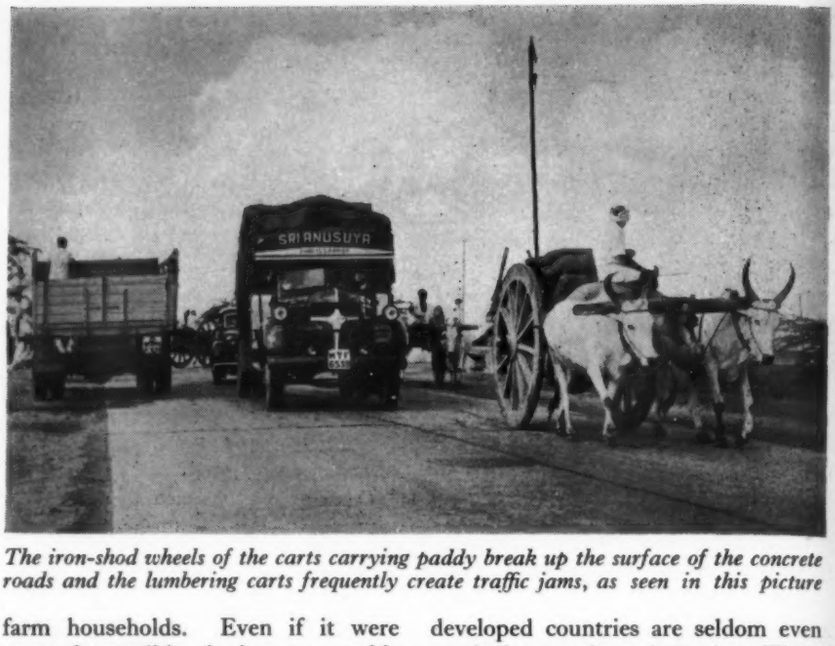
Threshing with oxen is traditional in India. Indian farmers are unanimous in their appeal for cheap and simple threshing machines; even the practice of driving tractors rather than bullocks round and round on the straw shows substantial economies in time and money

taxes. His diet improves, as does that of those to whom he sells his farm surpluses for cash.

Through ever more extensive purchases of consumer goods, especially consumer durables, he further stimulates industrial production. *In fact, he attains, and begins to enjoy and cherish, a higher standard of living.* This is something he will not easily forego once it has been experienced. The possibility of first grasping it, and subsequently improving it, acts as perperpetual self-igniting incentive to strive ever harder and higher.

But before this ideal state of affairs comes into existence some initial impetus must be built up. We can easily agree that a balanced economy demands a two-way flow of goods between the agricultural and industrial sectors, with the price system providing incentives on both sides. *The critical difficulty in India* and other low-income countries, however, *lies in first extending these preliminary incentives to the farmer.* Without the barest possibility of attaining them (and this demands his knowledge of their existence at least) he cannot reasonably be expected to make advances of any kind at all.

It is clearly impossible, for instance, to create an extension service large enough to carry irresistible counsels of perfection to the 61 million Indian farm households. Even if it were remotely possible, the insurmountable problem of ensuring long-term motivation would still remain. In short, *motivation can only be implanted and maintained by the constant provision of suitable incentives for the farmer in under-developed countries from the moment increased production, in pursuit of economic goals, is demanded on a national basis.*



The iron-shod wheels of the carts carrying paddy break up the surface of the concrete roads and the lumbering carts frequently create traffic jams, as seen in this picture

Passive resistance to progress

Unfortunately, farmers in under-developed countries are seldom even passively receptive to incentives. There is often, and certainly in India, positive disinclination to increase production. This has its roots in social habits of great antiquity. Many ingrained and environmental handicaps have to be removed, or neutralised, before the prevailingly negative attitude gives place to the mere consideration of an inducement to produce more. It might well be said that this is characteristic of all subsistence farming.

The nature of the incentives that might appeal to the subsistence farmer must be carefully studied. Little work has been done in this respect. The State-controlled economic devices producing fair prices and allowing profitable marketing are well documented, although they can not even be called completely successful in the developed countries of the world. These are an essential pre-requisite to the motivation of the low-income farmer.

Here bags of paddy have been dropped ready for spreading on the hot concrete

Money sense essential

His rewards, if they are to impel him to extra effort, must go deeper than this, however. Much of his simple economic activity is based on barter. He must first acquire experience in handling and reckoning the value of money. Critically important, once a cash outlook has been established, is his appreciation of what cash can do for him.

Here we link up again with overall economic goals. Generally speaking, it will be impossible to provide an

adequate incentive system for subsistence farmers unless overall economic planning takes care to bring into existence the goods and services on which such farmers can spend the cash surpluses derived from their newly-won crop surpluses.

The Indian Third Plan affirms that: 'The principal objective of long-term development is to secure a progressive rise in the level of consumption per head. This rise in consumption can only be achieved through a large and continuous increase in *per capita* production . . . Development has to be so planned and organised that the economy expands rapidly and becomes self-reliant and self-generating within the shortest possible period'. This is orthodox and admirable.

What has been overlooked so far, however, is that the additional agricultural production, on which all depends, is very largely dependent, in turn, *on the prior provision of sufficient inducements to the Indian farmer to abandon his traditional outlook and to accept the precarious and unaccustomed role of an economic individual.*

Voluntary co-operation

Such inducements, especially those in the form of consumer goods attractive to the farmer and arousing his desire to possess them in exchange for his cash surpluses, must be offered in increasing quantities during the next five years. With them in front of him the Indian farmer will automatically align himself with the national economic goals even if he knows nothing about them. In the pursuit of his personal satisfactions he will set off a production explosion entirely unattainable through the authoritarian relaying of instructions on which current expectations seem to be based.

In achieving the increased farm production set by national targets, the low-income farmer will then demand every aid to improved farming now enjoyed by farmers in more fortunate lands. Once suitable incentives for him are assured the immense task of providing these aids (the lack of any one of which will form a critical limiting factor to further progress) will fully occupy planners, officials and those concerned with social welfare form any years to come.

Diagram A summarises the dynamic concept of development economics. The origin of all progress lies with farming—the hub of the flywheel. The critically important centrifugal effects can only arise once the flywheel has started to spin. Their intensity depends on the rate of the flywheel's revolution. But the first few revolutions preceding independent motion can only be induced through the motivational impulses of the starting engine.

Finally, the tendency of the flywheel, impelled by the mighty engine of balanced economic development, to keep revolving provides stability and reduces the risk of inflation through the peripheral matching of money with goods and services. This flywheel must rotate faster and faster if the under-developed countries of the world are to attain full economic maturity.

Summing up

It has been shown that an immediate intensification of mechanisation to rational levels would confer several conclusive advantages on the Indian economy. The disadvantages commonly predicted by superficial observers can safely be discounted. The digression on simple development economics has demonstrated that progress is absolutely dependent on higher farm production *per capita*. This will be achieved only through the provision of suitable incentives, which will generate, in turn, forces leading the farmer towards a higher standard of living.

The completion of the argument, therefore, lies in the realisation that higher standards of living depend on higher production *per capita* anywhere in the world. One cannot exist without the other. It follows that the attainment of higher production *per capita* demands increasing mechanisation of tasks hitherto carried out with bullocks or by manual labour.

Under tropical conditions, especially, there is a well-defined limit to unaided human capacity. Man alone, with perhaps a lean pair of oxen, must strive desperately in order to achieve even mere subsistence. Higher goals, such as are implied in plans for economic development throughout the world, are entirely dependent on national capacity to put productive

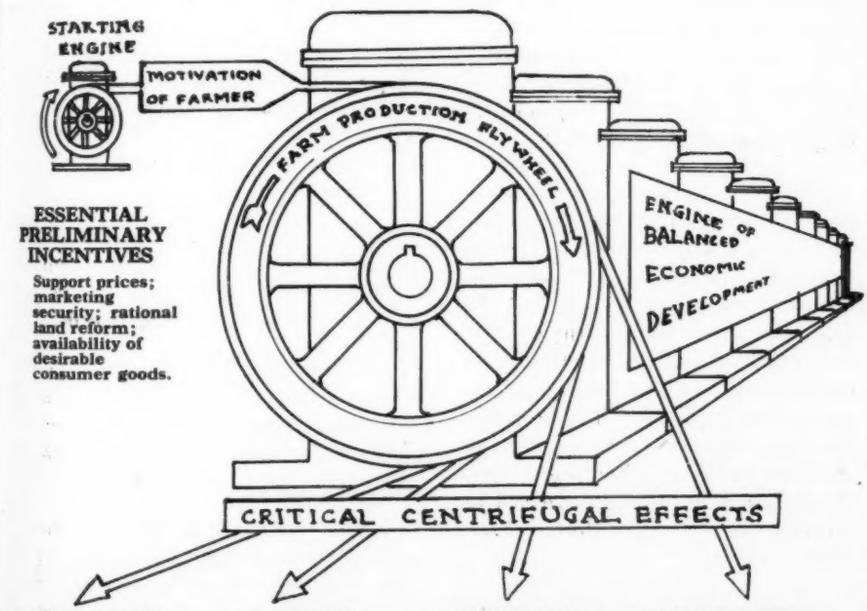

STARTING ENGINE
MOTIVATION OF FARMER
FARM PRODUCTION FLYWHEEL
ENGINE OF BALANCED ECONOMIC DEVELOPMENT
ESSENTIAL PRELIMINARY INCENTIVES
Support prices; marketing security; rational land reform; availability of desirable consumer goods.
CRITICAL CENTRIFUGAL EFFECTS
HIGHER STANDARD OF LIVING ON THE FARM
More varied diet; better clothing; improved domestic amenities.
INCREASED FARM CONSUMPTION
Major stimulus to industrial production and marketing; rate of monetary flow intensified; farmers' purchases absorb extra money from increased national production to combat inflation.
DISPOSABLE CASH SURPLUSES
Farmer becomes an economic individual; money flows into industrial sector; financial basis of essential farm investment is assured.
HIGHER FARM PRODUCTION PER CAPITA
Surplus food supplies for urban population; agricultural raw materials for industry; farm commodities for export; lower cost of production per unit; improved national diet; releases manpower for industry; money flows into rural sector.

DIAGRAM A. FARM PRODUCTION FLYWHEEL

tools, not least among them farm tractors, into the hands of the basic producers—the farmers.

Should such developments bring about recognisable unemployment in rural areas (and this is by no means a foregone conclusion), it must be regarded as a lesser evil than the rigid *status quo* of subsistence farming and the economic decay which are the alternatives.

The effect of increased farm efficiency must be to help inject labour supplies into the industrial enterprises which are so important a part of national development. Immense numbers of workers will be needed for just such contingencies. At the worst, some unemployment must be endured, as a form of national sacrifice, if any economic progress whatsoever is to be achieved, for the increased production of food is the fundamental priority.

An honourable appreciation of the situation demands that planners and politicians alike help the underdeveloped peoples to realise that future benefits can only be secured through the loss of many of their existing rights and privileges. The period of breakthrough will demand austerity, true self-discipline and even privation. The prerequisite for success consists in preparing sure foundations for rural prosperity, based on farm efficiency, as the forerunner to an integrated and developed economy.

Let farmers be provided with every conceivable aid to increased production. And let us make an end of the untidy thinking that condemns farm mechanisation under low-income conditions without reflecting that continuing incentives depend on the increased production *per capita* that can be achieved through mechanisation alone.

REFERENCES

7. Bauer and Yamey: 'The Economics of Underdeveloped Countries', Cambridge, 1957, pp. 224, 227.
8. Third Five-Year Plan: *Ibid.*, pp. 5-6.

Coming Events

Horticulture.—An International Exhibition of Flowers and Plants is to be held in Turin from 28 April-7 May. Details from the Fiori del Mondo a Torino, Esposizione Internazionale, Via Pomba 23, Turin, Italy.

The Chelsea Flower Show will be held at the Royal Hospital, London, from 16-19 May. Particulars may be obtained from the Royal Horticultural Society, Vincent Square, London, S.W.1.

Crop Protection.—The 13th International Symposium on Crop Protection will be held in Ghent on 7 May. Enquiries should be addressed to: Prof. Ing. J. Van den Brande, Institut Agronomique de l'Etat, Coupure Gauche 233, Ghent, Belgium.

Fertilisers.—The Fourth Congress on Fertiliser Problems will be held at Opatija, Yugoslavia, from 9-12 May, 1961. This congress is organised every fourth year by C.I.E.C. (Centre International des Engrais Chimiques) and C.I.T.A. (Confédération International des Techniciens de l'Agriculture). Applications to: Secretariat General, C.I.E.C., Beethovenstrasse 24, Zurich, Switzerland.

Grassland Research.—The Grassland Research Institute at Hurley will hold its Open Days this year on 27 and 28 June. Members of the public are invited to attend and may obtain further details from the Institute, Hurley, nr. Maidenhead, Berkshire, England.

Fruit Spraying.—There will be a top fruit spraying machine demonstration on a farm near Sittingbourne, Kent, England, on Friday, 2 June, in which tractor-drawn and tractor-mounted machines, both British and foreign (marketed and serviced in U.K.), will take part. Admission free. Particulars from the Secretary, Royal Agricultural Society of England, 35 Belgrave Square, London, S.W.1.

Tropical Agriculture.—A Preparatory Course in Tropical Agriculture has been arranged by the Oxford University Committee for Commonwealth Studies from 3-15 July. The course is intended primarily to help those who are going to the tropics for the first time to take up agricultural appointments. There will be no charge for the course other than for accommodation in Oxford. Enquiries should be addressed to Mr. G. B. Masefield, Department of Agriculture, Parks Road, Oxford.

Irrigation.—An International Course on Irrigation in Sub-tropical Regions will be held at Emek-Hefer, Israel, for six weeks from 1 August. Applications should be sent (with an accompanying letter of recommendation from the applicant's superior officer and a short description of their present work) before 30 April to: Irrigation Extension Centre, Post HaMidrasha LeHaklaut, Emek-Hefer, Israel. (See also page 150.)

Agricultural Exhibitions

Yugoslavia.—The 28th International Agricultural Fair will be held in Novi Sad from 29 April-8 May. Further information from Novosadski Sajam, Hajduk Velkova 11, Novi Sad.

S. Rhodesia.—A Central African Trade Fair and Exhibition will be held in Bulawayo from 3-14 May. Details from the Development Officer, Bulawayo Agricultural Society, P.O. Box 1776, Bulawayo.

Sweden.—A European Agricultural Fair will be held in Jonkoping from 25 May-4 June. Apply to: European Agricultural Fair, Jonkoping, Sweden.

New Zealand.—The Waikato Agricultural Winter Show will be held in Hamilton from 30 May - 6 June. Details from the Waikato Winter Show Association, Box 616, Hamilton.

England.—The Royal Show will be held this year in Cambridge from 4-9 July. Enquiries should be addressed to the Secretary, Royal Agricultural Society of England, 35 Belgrave Square, London, S.W.1.

Congo.—An International, Commercial, Industrial and Agricultural Exhibition has been planned from 8-23 July in Elizabethville. Information from the Secretary-General, Elizabethville International Fair, 2180 Avenue Leman (P.O. Box 1916), Elizabethville, Republic of Congo.

Cotton and Water Use in Israel

Making a Little Go a Long Way

C. H. BROWN, B.SC.*

Water is the real limiting factor in the economy of the new state of Israel, but even with the handicap of a low and erratic rainfall they are making the desert bloom.

THE usual picture of Israel is of a country trying to accommodate a growing population, both native and immigrant, on a limited land area. At closer quarters the available land does not appear to be so limited, but what is thrown into sharp relief is the acute water strain in the whole economy. The problem is accentuated by the political tensions which prevent any comprehensive planning for the utilisation of the waters of the River Jordan as an economic whole.

The large area of the Negev, stretching from Beersheba down to the Red Sea port of Eilat, has been desert throughout historic times and would appear to be as likely to have any short-term prospects of agricultural development as is the great Sahara.

One view sees as the main, perhaps the only serious prospect, the large-scale desalting of sea water. Such a magnificent achievement, whether through nuclear or other power, would obviously completely alter the agricultural potential not only of the Negev but also of desert areas in other parts of the world. This, then, is one of the major problems being studied at the Arid Zone Research Station at Beersheba.

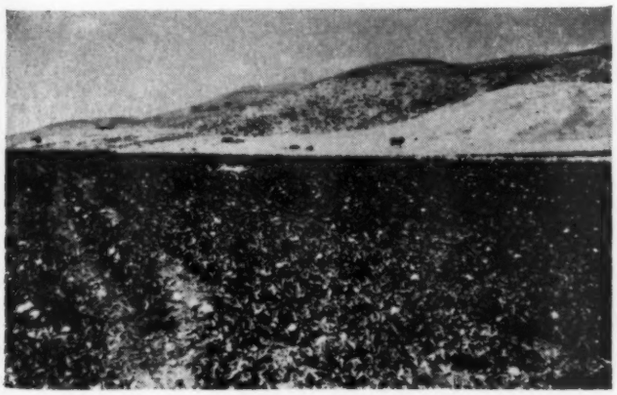
The Promised Land

This historical town, whose name means 'seven wells', divides the true desert, lying south of it, from the more promising area to the north, where there is land which can produce good winter crops when the rainfall is abundant, but on average the rains fail in about one year in every seven. Furthermore, any summer crops produced here are entirely dependent on irrigation.

As now planned, water is to be obtained from two sources. One is the Yarkon, a small river flowing out to the sea beside Tel Aviv, while a second major project is to take water from the River Jordan before it enters the Sea of Galilee far to the north and lead it to the Negev desert.

On the main coastal plain the winter rainfall is usually heavy enough to replenish the aquifers† which are drawn on by the main wells in this old-established irrigated area. But here, too, the water situation is likely to become increasingly acute as urban requirements go on increasing.

† Aquifers: water-bearing strata.



Cotton growing in Israel on what was formerly desert land

Citrus and cotton

Of the irrigated crops at present grown in Israel, citrus is the principal item of export, the well-known Jaffa oranges having an established place on the European market. Among the newer crops, cotton has recently attracted considerable attention and its cultivation has been surprisingly successful. As well as producing American-type cotton for the local mills, experiments have been carried out with the Egyptian type and the results of these trials have been well received by the Lancashire cotton spinners.

*Author of *Egyptian Cotton*, Leonard Hill, London, 1953. Price 16*s*.

Close-up of an individual cotton plant in Israel

Irrigated cotton

It is becoming increasingly appreciated that one of the advantages of cotton, as compared with citrus or any other suitable irrigated crop, is its low water requirement. The indications are that a typical irrigated cotton crop can be obtained using only about two-thirds of the water normally required for the same area of citrus, a point which is likely to become more important as water stringencies develop.

The water requirement may also decide the issue between the American and Egyptian types. These two are different species of the same genus, *Gossypium*, but there are differences in their root systems and structure. No data is anywhere available regarding their individual water requirements, but in Israel the indications are that *G. barbadeuse* (the Egyptian type) requires less water. This is understandable in view of its better tap-root system. Research to obtain precise information has already been initiated in Israel.

Non-irrigated cotton

The Egyptian type has been chosen for a most interesting experiment in non-irrigated cotton. One hesitates in this case to use the usual term, rain-grown, because even in the Galilee hills, the most northerly area of Israel, the rains cease between April and October. They are, however, more abundant in the winter and more dependable than in regions further south, and mainly for this reason the Galilee hills have been chosen for this agricultural adventure.

Owing to the rain distribution, the crop will have to make maximum possible growth on stored soil water and success will depend on several important requirements.

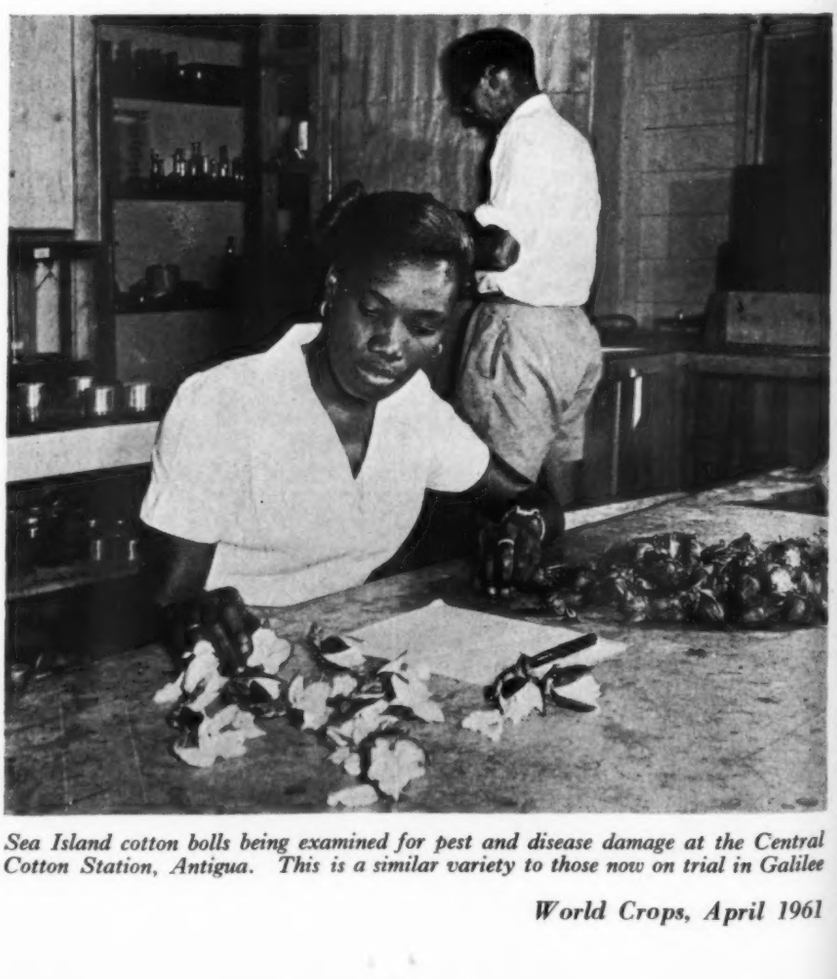
The first is soil preparation in the autumn to ensure maximum water penetration and retention. The usual pattern of the winter rains here is of sharp storm bursts, interspersed with periods of fine sunny weather, and the run-off of storm waters in gullies and streams can be considerable. To reduce this is the first essential.

The second is the timing of sowing. There is always considerable variability in the winter rains, which tail off in March and April, with some uncertainty as to how much more rain is still to come. At this time the soil and air temperatures are rising and experience is needed to decide the earliest practical sowing date. This is a problem which does not arise with irrigated cotton, *viz.* the possibility of worthwhile rains still to fall, which could make an important difference to early growth. This clearly suggests that sowing at the earliest possible date is important.

New transplanting technique

To meet this situation a new technique of transplanting from cold-frame nursery beds has been proposed. This is not a usual practice in cotton growing, but obviously transplanting should be possible at the time when seed would normally be sown. The hope is that the already developed root systems will be able to make better use of the hoped for late spring rains than would younger seedlings produced *in situ* from seed. It may well be that this advantage would, on balance, justify the extra cost in hand labour, and so the idea is being examined.

Meanwhile, the crop as now grown has shown satisfactory development, but this is associated with less vegetative growth than is the case with an irrigated crop with, of course, a lower average yield. Nevertheless, there is a compensating advantage in this smaller leaf area and earlier leaf fall. This makes cropping easier and clean cotton can be picked without any special care.



Sea Island cotton bolls being examined for pest and disease damage at the Central Cotton Station, Antigua. This is a similar variety to those now on trial in Galilee

Cotton the best crop

In the prevailing conditions it is not necessary to make any comparison between the economics of this non-irrigated cotton and the normal irrigated crop. The main issue is whether a crop can be produced at all in areas which would not normally be considered for irrigation or for which there will be no water available in the foreseeable future.

The real issue is between non-irrigated cotton and the other non-irrigated crops at present grown in Galilee. These are primarily sorghum, maize and sunflower for feed crops, with tobacco as a cash crop, and the indications are that cotton will show a greater cash return per acre than any of these.

Furthermore, in the intensive agriculture which seems inevitable for Israel in the future, the high labour requirement with non-irrigated cotton could actually be a point in its favour rather than the reverse. Around Nazareth, where the Arab minorities are mostly concentrated, small family cotton holdings could play an acceptable part in their economy.

There seems no obvious reason why a crop which is a success in Galilee could not also be grown further north, where the terrain and conditions are similar. The valleys in these hilly regions are often natural basins, collecting and retaining water from the hills in exactly the same way as they collected their valley soils in the past. Erosion is not all loss and the poverty of the hills today has its counterpart in the pockets of excellent soil in the valleys. The problem now is to find the right cash crop to make the most economic use of these hillside plots and to allow the whole area to develop an agricultural economy above a mere subsistence level.

Sea Island cotton

Top-quality cotton of the Egyptian type, perhaps specially selected for these particular conditions, seems to provide the answer, but by world standards it would give a smaller crop; but so does the high-quality Sea Island cotton,[1] which is also often grown in similar small valley or hillside plots. In spite of the geographical differences, the rain - grown West Indian Sea Island cotton has points of considerable agricultural similarity with the varieties now on trial in Galilee.

The more such a low water-demanding crop as cotton can be developed in Israel, the more the limited supplies of water can be made available for other crops and for the drier districts further south.

REFERENCE

1. Brown, C. H.: *World Crops*, 1960, **12**, 185. —'Sea Island Cotton'.

Sea-water Desalination

It is well known that by freezing an unsaturated brine solution, pure ice crystals are formed. This physico-chemical principle has recently been applied to the desalting of sea-water by an Israeli engineer, A. Zarchin, the process being based on the separation of fresh water from brine by fractional crystallisation.

The sea-water is passed into a high-vacuum evaporator, where it is partially vaporised. This causes the bulk temperature of the solution to drop and, as a result, partially freeze. The salts remain and accumulate in the liquid phase, producing a highly concentrated brine which is discarded. The solid phase consisting of pure ice crystals is brought into contact with the previously extracted water vapour and melted, to produce fresh water suitable for irrigation and for industrial and domestic purposes. Preliminary cooling of the sea-water is effected by passing it, along with the concentrated brine, through a heat exchanger.

The American company, Fairbanks-Whitney, has shown interest in this process and three engineers have been sent to Israel to design and erect a semi-industrial plant in Eilat on the Red Sea. It is estimated that this will take at least two years; after this it will be possible to determine the real cost of desalination per cubic foot of sea-water.

NOTE FOR CONTRIBUTORS AND AUTHORS

The editor welcomes authoritative articles and news items on agricultural machinery and agricultural methods, agricultural crops and new developments.

It should bear the name and address of the author and be accompanied by sharp photographs or line drawings with suitable captions.

Measuring Water in Soils

Australian scientists are using a neutron moisture meter to measure the amount of water in soils. This new instrument, developed by the Australian C.S.I.R.O. and the University of Adelaide, is based upon the ability of hydrogen atoms to slow down and scatter fast neutrons. Hydrogen atoms are the most effective of all the common soil constituents in diminishing the speed of neutrons. If neutrons are projected into the soil, the extent to which they are slowed down is therefore very largely dependent upon the number of hydrogen atoms in that soil.

The neutron source is a mixture of radium and beryllium. This, together with a slow neutron counting tube, is incorporated in a narrow cylinder, or probe, about 16 in. long, which can be lowered by its connecting electric cable into a prepared access hole. The remainder of the apparatus consists of a 'scaler' to which the probe is connected which contains the electronic equipment required for counting the slow neutrons. The complete meter, apart from the 6-volt accumulator which serves as the power supply, weighs about 25 lb. The access holes are prepared carefully and are lined with polythene tubing to prevent the soil caving in.

The instrument works in the following way:

Fast neutrons are projected into the soil; they are slowed down by collisions with hydrogen atoms, most of which are present in the water fraction in the soil. The more water present, the more hydrogen is present and the more collisions occur; the more collisions, then the more neutrons are slowed down. A measure of the slow neutrons is therefore a measure of the soil's water content.

The water content is determined by inserting the probe to the depth desired and making a count of the slow neutrons produced over a measured interval of time.

Calibration curves have been prepared which show the relation between numbers of slow neutrons, as indicated by the counter, and the water content of the soil. This relationship is not affected by soil texture. Each measurement indicates the amount of water present in not less than 1 cu. ft. of soil.

Tea Production in Caucasia

Production Potential and Problems

C. R. HARLER, PH.D.

The author toured the tea districts of Turkey in April 1960 and those of Iran in the following August. The observations made in this article are based largely on these two visits.

THE tea-growing areas which are here collectively referred to as Caucasia include the Black Sea coastal belt — from Sochi, just north of Georgia, U.S.S.R., to Ordu in Turkey —and the shores of the Caspian Sea— from Chalus to Rasht in Iran.

Plucking tea in Iran. The bushes are low pruned, close plucked and are rarely taller than 18 in.

While Russia has been a tea-drinking country from earliest times, in Turkey and Iran the habit is more recent, although tea consumption there is now rapidly increasing at the expense of coffee, which must be imported. All three areas aim at meeting their domestic requirements and in due course to produce tea for export.

Caucasian tea areas

Tea was first introduced into Georgia, Russia, in 1892, but only since 1926 has development been rapid. Experimental tea areas have recently been put out in many districts of the U.S.S.R. and these include Transcarpathia near the Czech border, the northern Caucasus, Central Asia, Vladivostok and Sakhalin on the Pacific. The main area is still in Georgia, with 92% of the total acreage under tea. Other areas of promise are Krasnodar, just north of the Caucasus, and Adjerbaijan, near the Caspian.

In Iran, tea culture started in 1898, but marked expansion only began in 1932. The area is confined to a belt, about 120 miles long, between the Elburz mountains in North Iran and the Caspian Sea.

In Turkey, planting began in 1939, since when development has been planned and orderly. The tea belt is a continuation of that in Georgia, and it runs along the Black Sea coast and adjacent hills for about 200 miles.

Table 1 shows the approximate acreages and out-turns in the year 1960 for these three areas.

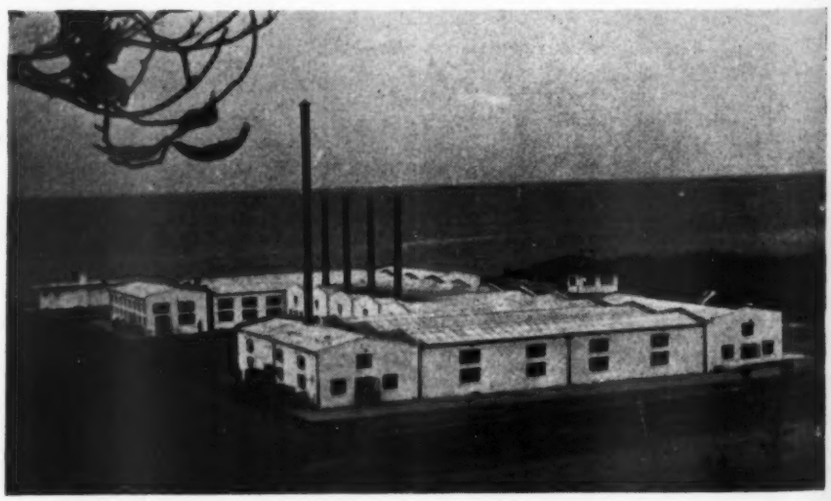
Table 1
Tea acreage and production

Country	*Area (acres)*	*Tea out-turn (lb.)*
Russia ..	180,000	80 million
Iran ..	41,000	20 ,,
Turkey ..	30,000	10 ,,

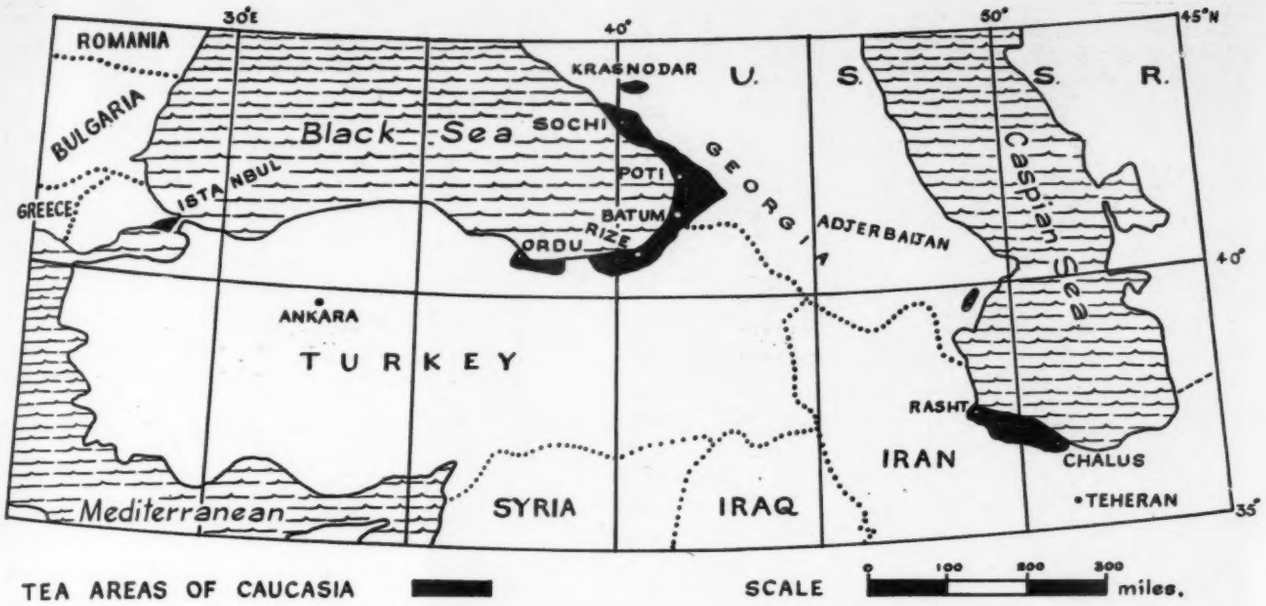
Within a decade, total production may well be doubled.

Climate and cropping

The climate of the Caucasian tea



One of the smaller tea factories on the Black Sea shore in Turkey



areas includes a wet, cold winter with frequent frosts from November to March and some snow. Such conditions call for a hardy plant and rule out the more delicate Assam types. The temperature rise in May is sudden, as is its fall in October. The summer heat is tropical, but rainfall is often short during the cropping season.

These conditions are very different from those in the tea districts of North-East India, where the winter season is brief, dry and cool, but not cold—and frosts are unknown. The hot growing season is subject to generous spring rains, followed by the monsoon in June. In Assam the crop is harvested mainly during eight months; if part of an estate is left unpruned, the cropping season may extend over 10 or 11 months. Even in Darjeeling, where temperatures are markedly lower than in the plains, the plucking season also extends over eight months.

Table 2 shows the monthly crop distribution in Caucasia, where, it will be seen, the plucking season lasts about five months.

Table 2
Crop distribution (% of total)

	Georgia	*Turkey*	*Iran*
April ..	Nil	Nil	7
May ..	25-30	45	23
June ..	15-18	6	20
July ..	20	26	18
August ..	20	17	15
September	10-15	6	13
October ..	2-3	Nil	4

In Georgia 88% of the tea is grown on about 700 collective farms and the balance on 32 State farms. The bushes are hedge-planted and are given a light cut across or 'skiff' prune in February or March and are 'tipped' above two or three leaves in April. The general form of the crop curve is similar to that in Assam, with a definite falling off between the first and second flushes in June.

In Turkey, the tea is grown by individual smallholders, who are in need of cash in the spring and strip the bushes of leaf at this time. The tea is often pruned in June and further crops are taken in the following months. The May rush is far beyond the capacity of the factories and quality suffers. A four-year pruning cycle, as commonly used in Darjeeling, is advocated in Turkey. This comprises a prune in the first year, followed in subsequent years by an unpruned, a 'skiffed' and then another unpruned year. This procedure would reduce the

Lecturing through an Interpreter

The author lecturing to Iranian tea-makers at Lahidjan in Persia. Mr. M. Dabir at the microphone is translating

The author (centre) *in a typical tea field near Rize in Turkey with Mr. Omer Bucukoglu* (left) *and Mr. Mevlut Kinez*

spring rush on account of the pruned year and increase the June and autumn crops.

In Iran the climate is not so severe as in the other two areas and the season is accordingly longer. In this country the bushes are low pruned and closely plucked, so that most of them never reach a height of even 18 in. If rational pruning and plucking measures were employed, yields would be more than doubled, although the crop curve would lose its present evenness.

The average yield in all three areas ranges from 450-500 lb. of tea per acre, but the best fields may yield double this crop. The average out-turn in Assam is about 1,000 lb. and the best estates make 2,000 lb. per acre.

Tea processing

In Georgia there are 63 tea factories, all State owned. In Turkey there are 16 factories, all Government owned. In Iran, out of 110 factories, 60 are Government owned or controlled and these deal with about 75% of the leaf plucked. In all three countries the tea industry is a Government monopoly.

The factories in all areas are well built and equipped and procedure is based on that in India and Ceylon. All the factories have withering lofts, many of which are controlled. In Georgia withering machines are under trial.

The make and appearance of the teas from Caucasia can be very fine, but the liquors are light, lacking briskness and strength, the best resembling low-grown Darjeeling rains teas. The valuable spring flavour given by China hybrid bushes in Darjeeling and the high-grown teas of Ceylon, fails to materialise in Caucasia.

Varieties grown

Broadly speaking, there are three varieties of tea plants within the species *Camellia sinensis*, and these are the China, the Cambodian and the Assam. There are many sub-varieties and hybrids.

The China and China hybrid types give light liquors, though very fine spring flavour under certain conditions. The Assam types give strong liquors, often with highly valued quality, but no marked flavour. The Cambodian variety and its hybrids generally give poor liquors with little flavour.

The tea plants grown in Russia are from seed brought from China, Japan, Darjeeling, Assam and Ceylon. The seed used in Turkey was originally imported from Russia and consisted of 14 types of the China and hybrid varieties.

The seed used in Iran came from the Kangra valley in the Punjab, whence it was probably imported from Assam in 1860. The stand in Iran has no China characteristics and it includes the Cambodian variety, the Manipuri and Burma types of the Assam variety and hybrids between these three.

Present problems

It is evident that in Russia and Turkey the climatic conditions do not permit of the production of worthwhile seasonal flavour from China or China hybrid plants, nor are the liquoring qualities of the teas good. Similarly in Iran, the Cambodian types produce neither flavour nor good liquors. In all three areas the build-up of a stand capable of giving brisk, strong, coloury liquors is desirable, if possible.

It is a long task to alter the nature of a tea stand. In the Assam valley it took 40 years, from 1920 onwards, over which period the original hybrid tea was uprooted and replaced by selected Assam types. But the effort was well worth while.

The tea industry in Caucasia today faces many problems, both in the field and in the factory. However, the main problem is that of selection of suitable types of plants which will give useful liquoring teas.

Six Young Australians

The six young Australians who are the winners of this year's P. & O. Canberra Award arrived on S.S. *Orion* for a crowded six months' tour of England, Scotland and Northern Ireland. They have come from each of the constituent states of Australia.

Their time will be spent in visiting agricultural research centres, agricultural training colleges, farms, farming organisations and farmers' clubs.

They are also to be shown the scientific background of British agriculture by visits to the National Institute of Agricultural Botany at Cambridge, the Macaulay Soils Research Institute at Aberdeen, the research laboratories of the Shell Chemical Co. at Woodstock and of Fisons Pest Control Ltd. at Chesterford Park. They will also visit the National Institute of Agricultural Engineers at Silsoe, the Ford Motor Co. at Dagenham, the Nuffield Organisation at Oxford, the Rover Car Co. at Birmingham, the Massey - Ferguson Organisation at Coventry, and Rotary Hoes Ltd. at Hornden.

Trucks carrying the cut cane to the factory are drawn by oxen over temporary railway lines in the fields. Diesel engines operate the cane trains over permanent lines to the factory

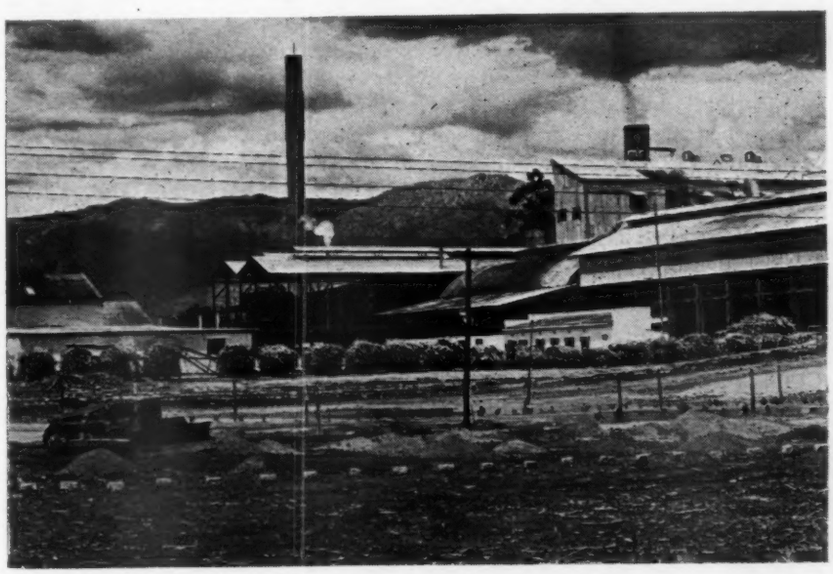
Sugar Cane in Kenya

One of the 4,000 cane cutters at work at Miwani sugar estate

ON the edge of the great Kavirondo plain, that curves about the Kenya shore of Lake Victoria and beneath the lush 3,000-ft. high wall of the Nandi escarpment, vast fields of sugar-cane rustle in the occasional breeze that disturbs the heat.

It was here, at Miwani, in Kenya's Nyanza Province, that the foundations of East Africa's sugar industry were laid more than 40 years ago by an Australian company. The Asian family which now owns the estate are planning to increase sugar production considerably during the next few years.

After establishing a drainage and irrigation system and fertilising the land new varieties of cane were planted by this company. Today there are five varieties under cultivation, with a further 90 types in experimental plots. There is a laboratory with a qualified soil chemist.



Right: *General view of the Miwani Sugar Mills, with a row of trucks delivering cut cane to the mills. The Nandi Escarpment is seen in the background*

Sugar-cane brought in from the fields is tipped into the conveyor belt for processing

Previously the sugar juice was concentrated in iron pans and crude jaggery was thus obtained. Miwani Sugar Mills, the first sugar refinery to be built in East Africa, is now in production. This project, together with a methylated spirit factory, will cost £900,000, giving the present firm a total capital investment of £2.3 million by 1963.

This—the largest sugar estate in Kenya—now produces an average of 800 bags of plantation white sugar a day. The estate has increased the acreage under cane from the original 5,000 acres in 1947 to 12,000 acres today. Sugar production in the same period has risen from 3,000 tons to 20,000 tons a year.

Miwani has, in fact, become a centre for agricultural training for the cane growers of Nyanza. Besides the advice they receive from the Agricultural Department, the workers have learned from their work on the estate and as a result now grow sugar-cane on their own lands. This crop gives one of the highest returns of any of the cash crops grown in Nyanza, an average of £45 per acre per year. Payments for the first deliveries of cane to Miwani have led to increased interest among the African population.

African-grown cane is already established at Chemelil, in Central Nyanza, and other areas have been surveyed for planting in East Kano.

The processing completed, the refined sugar is bagged and sent by conveyor to the warehouse

Beetles that Bore

Grubs of the long-horned beetle, *Oemida gahani*, are ruining cypress and podo trees in Kenya. It was once thought that this beetle was found only in structural timber, but when a cypress plantation in the Kinankop Mountains was thinned out in 1949 the felled trees were found to be full of holes caused by the *Oemida* grub. The beetle is difficult to detect because, no matter how badly it damages the heartwood, no marks show on the outside of the tree.

The beetle hatches out from eggs laid on a broken branch, pruning scar, or damaged area of the trunk, and immediately bores its way into the heart of the tree—the dead wood—where for the next two years it eats its way through the galleries up and down the centre of the tree, digesting the cellulose and other food and packing it tightly behind it as it moves. On reaching the pupal stage it finds its way out of the tree, mates and the life cycle begins again.

Much work has been done on methods of keeping the *Oemida* beetle out of the trees. The stumps, for instance, in which the beetle can live can be destroyed, but it is thought that it may be cheaper in the long run to replace cypress with a species of tree which the beetle does not like, such as pine, which is also quick growing, light and strong.

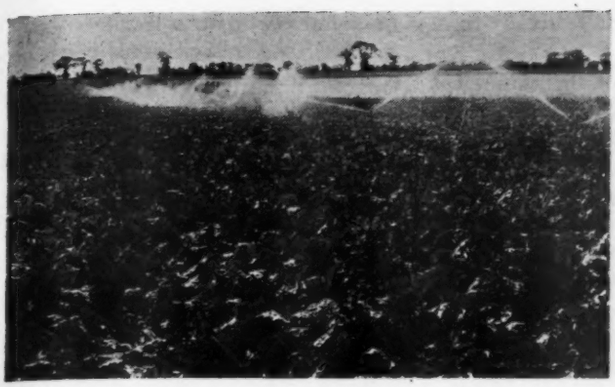
Kenya's Forestry Department is therefore growing experimental plantations of pines—radiata and patula—while entomologists are studying the treatment of pruning scars and the survival limits of the beetle.

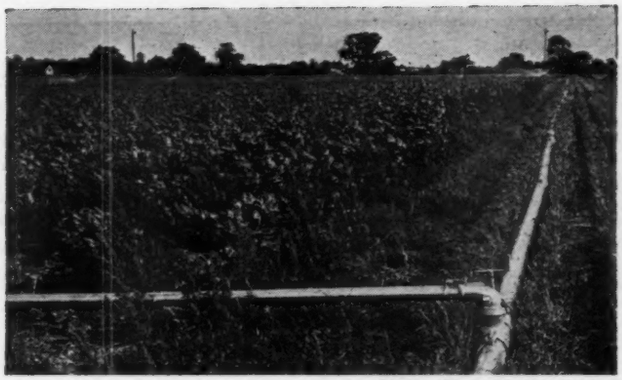
African Tea Growing

Plans to develop 9,000 acres of African-grown tea, at a cost of £960,000, over the next eight years have been announced by the Kenya Government and the Colonial Development Corporation. The scheme, which will involve about 9,000 smallholders, will expand the growing of tea from the present small areas to other potential tea-growing areas of Kenya.

This smallholder development in the Central, Nyanza and Rift Valley Provinces of the colony will be controlled by a new statutory body, the Special Corps Development Authority.

The Colonial Development Corporation has undertaken to lend up to £900,000 and the Kenya Government will lend £60,000 in addition to providing the necessary roads and staff accommodation.





Photos: Farrow & Sons Ltd.

A 5-acre field of sugar-beet being irrigated by a portable sprinkler system. The application rate is 1 in. of water every 3½-4 hours, twice in the season. The result was 20 tons to the acre, as against only 12 tons to the acre for a non-irrigated area. Right: *Section of the half-mile length of 5-in. piping showing the take-off points to which the portable lateral piping is attached. These laterals each carry 48 sprinklers. Water is drawn from a stream by a tractor-driven centrifugal pump*

Cambridge Irrigation Conference

IT is a platitude that all crop production is dependent on moisture, and where the rainfall cannot be relied upon, the adverse effect of a period of drought, particularly in the critical stages of development of a crop, can be very serious. This was the theme of the Second Irrigation Conference held at Cambridge and presided over by **W. T. Price,** *Principal of the Harper Adams Agricultural College.*

In his address the chairman said it was important to take into consideration the tremendous variations in the incidence of rainfall from season to season and he instanced the conditions in the Shropshire plain during the past three seasons:

Table 1

Rainfall in inches

Year	*April 1 to June 30*	*July 1 to Sept. 30*
1958 ..	5.98	14.86
1959 ..	6.11	2.63
1960 ..	4.72	11.33

He emphasised that in plant growth the two main limiting factors are lack of moisture and low temperature—in that order. Moisture was important in the early stages of plant growth to prevent a check in root growth, when the rootlets are small, and when competing weeds can overtake the growth of the young plants.

He referred to the impending legislation on irrigation, saying that it must be borne in mind that the amount of surface and underground water in Britain was limited. It must be used most usefully and must not be wasted. Ultimately water may have to be rationed and it may even be necessary to collect drainage water and use it again.

With the increase in the use of slatted floors in dairies animal residues are now being washed down and it is important not only to use the resulting sludge usefully on the land, but also not to waste the water in the sludge by sending it to the sea via the drains.

The occasion provided a forum for irrigation experts, advisory officers and farmers to discuss the pros and cons of the new farming technique of sprinkler irrigation. The following is a short summary of some of the papers presented, each of which was followed by a lively discussion:

Irrigation for Farm Crops *by J. J. North (N.A.A.S.)*

It is apparent that more water than is available could be used for irrigation in Britain. It is important, therefore, to select the crops which will give the best results and to apply the water to the crop only at the moisture-sensitive stages. Irrigation appears only to be economic if it is controlled and correctly applied.

Potatoes are a crop which should receive priority, as both yield and quality are seriously affected by drought, *e.g.* 1947, 5.8 tons per acre; 1953, 8.7 tons per acre. With early potatoes the most economic treatment is the application of 1 in., when needed, throughout the life of the crop; with maincrop potatoes the best return is obtained by withholding irrigation until the tubers commence to form and to stop irrigating five days before harvesting.

With grass, the closer the soil is maintained to near field capacity, the more vegetative growth is obtained. In theory, therefore, it would be necessary to return the soil to field capacity each day to obtain the maximum yield of grass. This is not economic, as it would require unlimited equipment. Grass requires water all through the summer and a total of 1 in. of water applied to the grazed fields and 1½ in. for hay and silage swards was arbitrarily put forward as the minimum worthwhile application.

Due to its rooting habit, sugar-beet will generally give smaller returns from irrigation. Irrigation is recommended when, after singling, the plants meet in the row and until the end of August, when 50% of the water reserves have been used up in the top 2 ft. of soil.

With vining peas the most economic treatment would appear to be to apply the water at late flowering; if done before flowering, the plants will make too much haulm. Wheat growing on light soils will respond to 1-1½ in. of

water applied during May if the spring is dry and this may increase yields by as much as 50% on such soils.

Every farmer should have a rain gauge and apply water only when the crop needs water and should apply only the amount needed to restore field capacity. Too much will produce waterlogged conditions and too little will produce shallow rooting. He urged that irrigation should never be used on land that is not properly drained. [*Every farmer should also have a tensiometer.—Ed.*]

Water Conservation for Irrigation *by S. Hawes (Agricultural Consultant, Suffolk)*

Less than half of the annual rainfall is held in the soil and in the water-bearing sands and rock; most of the water passes out to sea and lost, and this mostly in the winter, when the rainfall is greatest; the problem is how best to hold it so that irrigation water was available when most required.

If the contours are favourable, small earthworks to dam a valley can produce large storage, but the cost of an adequate spillway to cope with flood-waters could be high. A side-valley reservoir involves more earthwork, but obviates the need for emergency over-flows, providing an adequate flood plain is left on the stream course.

One of the most common forms of water conservancy is to have a high-ground reservoir built on an impermeable foundation with a pumped supply of water. The pipeline used for filling it can also be used as the delivery pipe for irrigation. The cost of an earthwork on a flat hilltop site can be quite economic in view of the fact that it will have greater capacity than an impounding or valley dam.

The cost of providing water storage was estimated to be about £1 per acre-in.*

Irrigation Costs and Returns *by J. S. Nix (Farm Economics Branch, Cambridge University)*

In a recent survey, the Farm Economics Branch of the Cambridge School of Agriculture investigated some 30 farms in the eastern counties of England. It was found that most of these used the rotating sprinkler system with portable equipment and had access to free water, usually from rivers.

The capital cost of the equipment ranged from £360-£3,500, according to the size of the installation. A small unit using a tractor-driven pump cost, on average, about £200; the sprinkler line to cover 1 acre at a setting about £300; and the main line from £1-£2 per yard, according to the diameter of the piping.

The capital cost per acre varies considerably, depending on the position of the water source, the shape of the areas irrigated and their disposition. Where a river is conveniently adjacent, the capital cost can be as low as £10 per acre where little main line is needed, but the average is nearer £20 and can be £30 where a long sprayline is required.

Naturally the cost per acre-in. will vary with the amount of water used, owing to the spreading of the fixed costs —depreciation and interest on capital; conversely, if the installation is little used the cost of water can be very high indeed. As more water is applied to a field only the variable costs increase —mainly labour and fuel.

The average cost of water was £2 6*s.* per acre-in. Of this, more than half represented depreciation and interest on the capital spent on the installation, £1 1*s.* of the balance was for labour and fuel, and miscellaneous costs for repairs etc. amounted to 2*s.*

Reservoirs are expensive, but the cost varies, depending on the water storage/earth ratio and the extent of the inlet and overflow works required. On the basis that for every cu. yd. of earth moved 2 cu. yd. of water can be stored, the cost of a reservoir is about £15 per acre-in. of water, applied to the land, allowing for some losses by seepage and evaporation.

This means that where 5 in. of water is required in a dry year, a reservoir to serve 100 acres would cost £7,500; this capital cost is equivalent to a spread-over cost of £4 10*s.* per acre per year, calculating depreciation over 15 years.

Boreholes can be very costly. The average was £3 a foot, ranging from £1-£8 for wells from 50-300 ft. deep, and a more expensive deep-well pump is required than if the water is taken direct from a river, using a tractor pump. For a farm of average size the installation may cost over £1,000.

For irrigation to show a profit there must, of course, be higher yields and better quality produce. All this depends on season, position of the land, the nature of the soil and individual skill of the farmer. There

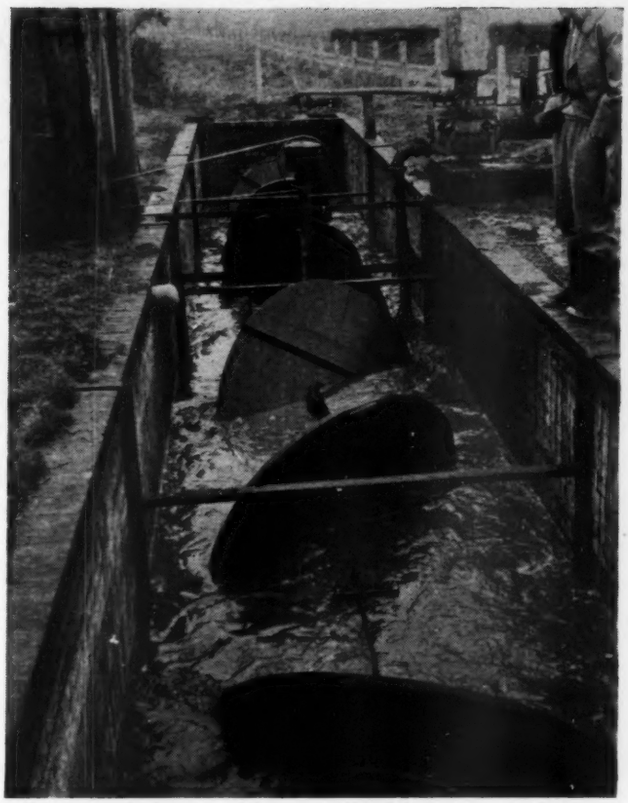
The giant Farrow '50' rain gun which is used for spreading the liquid manure over the pastures. It can be moved from point to point to irrigate the various parts of the field

* Acre-in.: 1 in. of water over an acre of land.

are obvious shortcomings in such experimental evidence as is available.

It is possible, however, to estimate the 'break even' yields. Thus if 2-2½ in. of water is applied at a cost of, say, £5 5*s.* per acre, the increase in the yield of potatoes must be ½ ton per acre, while for sugar-beet an extra 1 ton per acre is needed to cover the cost. [*This, of course, refers to conditions in Britain with about* 30 *in. of annual rainfall. In arid regions and where droughts are liable to occur it is essential to supply water if crops are to be obtained at all.—Ed.*]

Grass is a more complicated crop than either of these cash crops. Irrigation can improve returns by giving higher milk yields per cow by substituting grass, hay or silage for concentrates, by increasing the stocking rate or by releasing land by obtaining the same milk production from a smaller acreage.



The slurry-mixing tank of the organic irrigation scheme in Staffordshire. The belt drive of the agitator can be seen top left and the special Bucher sludge pump is top right

Organic Irrigation *by T. Garbett* (*Farrow & Sons Ltd.*)

Organic irrigation is the name that is given in Britain to a method of muck farming which is known as the 'Gulle' system in Germany and Switzerland and as 'Fertirrigazione' in Italy. Otherwise expressed it is a system for the mechanisation of muck with easier handling than in the past and the double benefit of the application of a valuable manure to the land, combined with irrigation.

The first requirement is to plan the system of drainage from the farm buildings and yards to a central cesspit, so sited as to give adequate drainage falls so that the muck will move and at the same time be convenient for pumping the diluted material on to the fields. Where rainfall is very high it is necessary to by-pass surface floodwaters away from the cess-pit to prevent excessive dilution of the muck.

The central cesspit, emptied of sludge, and showing the wooden paddles and the stoneware pipes which carry the diluted muck from cowsheds, stables, pigsties and the farmyard

Dilution is an important factor, particularly when putting the liquid manure on grass in the summer. Naturally, if the manure is too strong, there will be leaf scorch; but, on the other hand, there should not be excessive dilution. The Swiss use dilutions with two, three or eight parts of water with one of muck; in British practice it is not usual either to drop below a dilution with five parts of water or to put the liquid manure on as thickly as do the Swiss. This is possible because their cattle are very rarely put out, either in summer or winter.

Yard, stable and cowshed washings are run by gravity into the central cesspit, which is fitted with wooden agitators, and the pumphouse for delivering the liquid manure adjoins it. Suggested sizes for the pit are 8 ft. x 8 ft. x 45 ft. or 10 ft. x 10 ft. x 30 ft., which will hold about 17,000 gal. of liquor, or the equivalent of ¾ in. on an acre. This is, of course, not the recommended rate of application, but merely an indication of the capacity of the pit. Normally not more than ¼ in. per acre is recommended.

The manure is stirred up by means of the wooden paddles, which are driven by an electric motor, and when evenly mixed a special twin-cylinder, double-acting piston pump by Bucher-Guyer of Switzerland, is used to draw up the contents of the pit and send it along the irrigation line to a Farrow rain-gun in the field under treatment.

On one farm in Ireland there were 4,000 pigs and 100 head of Friesians producing 6,500 gal. of undiluted muck every day. Even with a dilution of only 3 : 1 this would provide an acre-in. of liquid muck for the 125 acres of grass owned by the farm. This is, of course, grossly excessive. In this case the total area available for spreading the muck was too small; the problem, then, was to find neighbouring farmers who could be reached with a reasonable run of pipeline.

One reason for the adoption of the system of organic irrigation on this farm was the nuisance that was caused by the farm effluents delivering into the river, since an order had been issued by the river authorities for the nuisance to be stopped.

World News

Thailand

Land Survey Planned

Thailand plans to survey its land resources this year as part of a six-year programme for economic development. Classifications will be made on lands for (1) national forests and parks, (2) crops, (3) livestock, (4) minerals and (5) irrigation projects. The survey will also include water resources and waterways. Training of officials for the survey has begun.

India

Plans for Soil Conservation

The Government of India is considering a programme of assistance to the constituent states for soil conservation in the catchment areas of river valley projects.

The proposed allocation for this programme in the Third Plan is £8.25 million, to be apportioned to major river valley projects, taking into consideration areas of catchment to be conserved, difficulties of terrain, urgency of conservation and organisational set-up which already exists to carry out this work.

Soil conservation in the catchment areas of major river valley projects during the previous Second Plan period had fallen short of the target. Moreover, more than one state was concerned with soil conservation and there was no co-ordinating agency for this purpose.

Rhodesia and Nyasaland

Rapid Expansion of Tea Industry

Tea production in Southern Rhodesia is expected to increase by 700% over the next 10 years, according to the Federal Minister of Agriculture, Mr. J. C. Graylin.

The present estimated tea output of the Federation is 26.5 million lb. a year. Nyasaland produces about 24.3 million lb., practically all of which is exported; the balance is grown in Southern Rhodesia, almost entirely for the internal market.

Mr. Graylin said that the areas available in Nyasaland for tea production were limited. In Southern Rhodesia, however, the potential for expansion is considerable and at the rate the tea industry was now developing it seemed almost certain that the value of the present output, now worth £263,000, would be increased to over £2 million in the next 10 years.

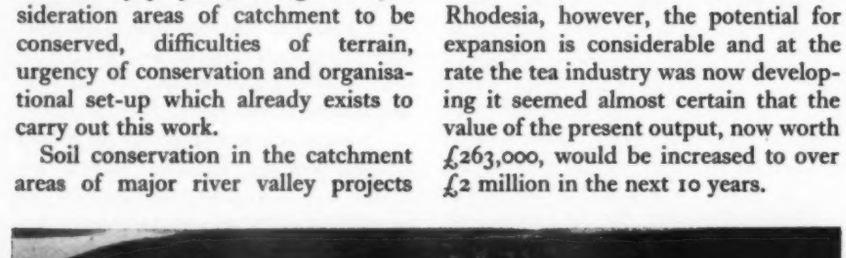
Israel

Course in Sub-tropical Irrigation

The functions of the irrigation engineer and the agronomist are complementary, for the mutual understanding of their problems will advance agricultural development for the benefit of the farmer and the national economy.

To foster such understanding an International Course on Irrigation in Sub-tropical Regions is to be held in Israel for six weeks from 1 August, with lectures in English, field problems and study trips. Those participating will be given an opportunity of presenting specific irrigation problems from their own countries, and as the course is to take place at the height of the irrigation season they will be able to study the surrounding agricultural environment.

The course is being held under the auspices of the Israel Irrigation Extension Centre, with the co-operation of FAO, UNO, the Israel Ministry of Agriculture, the National and University Institute of Agriculture and the Technion-Department of Agricultural Engineering. Further details in 'Coming Events' (page 138).



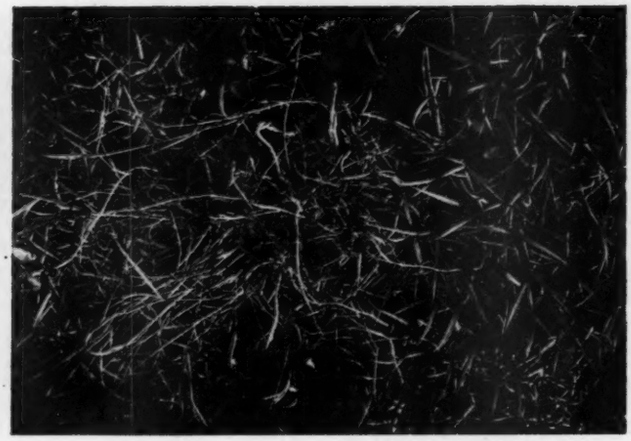
Eucumbene Dam, in the Snowy Mountains, is one of the world's highest earth- and rock-filled dams. Half a mile thick at the base and 381 ft. high, it holds back a reservoir with a gross storage capacity of 3.8 million acre-ft.

Australia

Snowy Mountains Project

The great Snowy River project is now nearing completion. This river previously flowed to the south-east coast of Australia, passing through areas which had adequate rainfall. This £A400 million project is to trap the waters high in the mountains and send them through tunnels westwards to the Murray River irrigation system. The total amount of water to be thus made available will be 1.8 million acre-ft. This quantity of water is expected to produce foodstuffs to the value of £30 million per annum.

This year it is expected that 500,000 acre-ft. of water will be brought to the Murray and Murrumbidgee irrigation areas and ultimately 1.02 million acre-ft. will go to the Murrumbidgee and 798,000 acre-ft. to the Murray River area. A 2,000 ft. difference in elevation makes the diversions practicable.



Photos: Plant Protection Ltd.

Agropyron Repens. Left: *Above ground.* Right: *The rhizomes growing underneath the ground*

Progress in Weed Control

4—The Problem of Couch

IN introducing the difficult problem of the control and eradication of couch grass, or quack grass, *Dr. G. R. Sagar*, of the *Agricultural Research Council, Unit of Experimental Agronomy* at Oxford, said that, although many regarded its presence on arable land as a symbol of bad farming, increasing mechanisation and shortage of farm labour had tended to make the conventional method of control (*by summer fallowing and cultivations—Ed.*)—uneconomic.

Other methods of control were therefore necessary and the introduction of rotary cultivators and the production of herbicides were major advances.

The success of the first method depended, he said, on the stimulation of dormant buds and the subsequent destruction of the resulting shoots. Control methods, which depend on the use of chemicals, rely for their success on many factors, both environmental and innate. The control so obtained was unpredictable, varying from occasional complete success to complete failure.

He suggested some of the causes of this variability. One explanation was that if the weed were allowed to complete its flowering cycle the seed subsequently shed will germinate in the soil in the year of its production. It is therefore important for the farmer to guard against the dissemination of the seed by farm machinery.

Rotary Cultivation for the Control of Couch *by J. M. Proctor* (*National Agricultural Advisory Service*)

It has been previously shown by Fail that rhizomatous grasses may be eliminated by from two to six rotary cultivations, kill being attributed to the exhaustion of the small rhizome pieces produced by the initial rotary cultivation. (WORLD CROPS 1959, 11, 241).

In order to obtain field experience of this technique, used in conjunction with chemical sprays, two experiments were laid down in 1959. Both sites were on a light silt soil with a heavy infestation of couch, mainly *Agrostis gigantea* with some *Agropyron repens.* One worker has considered 119 in. of rhizome per square foot to be a heavy infestation, but these trials had an infestation of about 800 in. per square foot or a 'rhizome yield' of about 2½ tons of dry matter per acre.

Rotary cultivation with adequate tractor power gave reasonable control, but if a chemical (amitrol, dalapon or TCA*) was combined with rotary cultivation rather better control was obtained than from either alone, but this was not sufficient to make the combined treatment worth while. Of these chemicals, activated amitrol appeared the most promising.

Rotary cultivation alone appeared more effective than herbicides used alone.

An Important Factor Affecting the Movement of Dalapon *by G. R. Sagar* (*Agricultural Research Council*)

During the course of an investigation into the factors controlling the pattern of movement of 2,2-dichloropropionic acid (dalapon) in experimental systems of *Agropyron repens*, an attempt was made to determine how far the transport of dalapon could be correlated with supposed pattern of movement of metabolites. One of the experiments to test this hypothesis involved shading a part of a plant and demonstrating that a herbicide applied to another part of the same plant moved readily into the shaded portion.

Using the technique of autoradiography, it was found that if a treated shoot is shaded, then the radioactivity is distributed widely within the experimental system, whereas an unshaded shoot retains the herbicide to a far greater extent.

This is a WORLD CROPS digest of the papers given in the 6th Session of the Fifth British Weed Control Conference held at Brighton in 1960.

* Used respectively as the commercial formulations 'Weedazol TL', 'Dowpon' and 'Tecane'.

It is suggested that a shade reduces the rate of movement of water in the xylem by increasing the humidity. Since dalapon is readily transferred from phloem to xylem, it is argued that the speed of downward movement of the chemical in the phloem will depend not only on the forces taking it down, but also on the rate at which the xylem draws it from the phloem. It seems likely that the faster the movement of water in the xylem, the more rapidly is the herbicide extracted from the phloem.

It is therefore suggested that humidity at the time of spraying and subsequently may be all-important in determining the success or failure of dalapon applications in the field.

Effects of Penetrant Aids and Wetting Agents on the Response to Dalapon of Couch *by J. K. Leasure* (*Agricultural Research Centre, Dow Chemical Co., U.S.A.*)

Since its introduction in 1953, 2,2-dichloropropionic acid (dalapon) has been of considerable interest because of its practical selectivity with grasses. In addition to many field trials, a large number of more detailed experiments have been conducted in attempts to determine its sites of action in plants, the method by which it is translocated in plants, and its ultimate fate in both plant tissue and soil. A number of experiments have been conducted with and without wetting agents. The present study was undertaken to determine the effect of some surface-active agents on the translocation of a sodium dalapon into the rhizomes of couch.

Prior to the start of this experiment a number of surfactants which had improved the herbicidal effects of dalapon on maize and soya beans were obtained:

Surfactant	*Type*	*Produced by*
'Duponal WA Flake'	Anionic	E. I. Du Pont de Nemours & Co.
'Ethomeen S-15'	Cationic	Allied Chemical Corp.
'Tergitol TMN'	Non-ionic	Union Carbide Corp.
'Polyglycol 26-2'	Non-ionic	The Dow Chemical Co.

Tests to determine retention on the leaves of couch and tests to determine the required dosage of dalapon-2-C^{14} showed that the non-ionic surfactants were superior to both the ionic ones. Accordingly, 'Tergitol TMN' and 'Polyglycol 26-2' were used in the rest of the experiments.

Tests using 2-C^{14} labelled dalapon formulations with and without anionic wetting agents resulted in a definite increase in the amount of dalapon-2-C^{14} recovered from rhizomes, untreated shoots and leaves when a wetting agent had been added to the solution. These increases in the amount of dalapon translocated were measured on uniform plants under conditions which avoided such variables as differences in leaf area covered by droplets of equal volume, but with different surface tensions, and differences in the amount of formulation applied per plant resulting from the influence of the wetting agent on retention of the formulation by the leaf.

Erratic results have previously been obtained in field applications of dalapon. These tests, run under controlled conditions with uniform plants, emphasise the need for a properly wetting formulation.

Trials with Dalapon for the Control of Couch (1957-59) *by S. A. Evans* (*N.A.A.S. Liaison Officer, Weed Research Organisation*)

This report summarised various trials carried out on farms by members of the N.A.A.S. to investigate the efficiency of dalapon at a range of doses and under varying conditions.

Seventeen trials, in which treatment of couch or bent, *Agropyron repens*, *Agrostis gigantia* and *Agrostis stolonifera*, with dalapon, at doses falling within the range of 4-20 lb. a.e. per acre, applied in all on 26 occasions, were carried out on farms by the N.A.A.S. in 1957-59.

Difficulty was encountered in making satisfactory assessments of the degree of control of grasses produced by chemical treatment, but the results showed dalapon to be unreliable in its effects under the practical farm conditions encountered in the trials. The trials are not capable of indicating the reasons for the variable results.

The Response of Agropyron repens to Amino Triazole *by K. Holly and R. J. Chancellor* (*A.R.C. Unit of Exp. Agr.*)

The herbicidal properties of 3-amino-1,2,4-triazole were first indicated about eight years ago (Behrens, 1953). There were also many early reports of effectiveness for the control of couch, but results were variable. In 1958 combinations of amino triazole and ammonium thiocyanate (NH_4SCN) were found to give an enhanced effect on *Agropyron* in the U.S.A.

In a series of pot experiments on *Agropyron repens* the 'activation' of amino triazole by NH_4SCN has now been verified. Some evidence indicated that the effect of NH_4SCN was not on penetration of amino triazole. A high degree of control was obtained with very low doses of amino triazole + NH_4SCN, but *Agropyron repens* established from rhizomes from a second site was less susceptible. In field experiments this herbicide was not so effective as in the pot experiments.

Control of Perennial Grasses with Dipyridyl Herbicides Alone and in Mixtures *by R. S. L. Jeater and H. C. McIlvenny* (*Jealott's Hill Research Station*)

In the study of the herbicidal activity of the dipyridyl herbicides, greenhouse and field trials were carried out to evaluate their effects on couch grasses, *Agropyron repens* and *Agrostis* spp. These herbicides were tested alone and in combination with established grass-killing chemicals, such as 2,2-dichloropropionic acid (dalapon) and 3-amino-1,2,4-triazole (amitrol).

These experiments indicated that mixtures of the dipyridyl herbicides with dalapon or amitrol gave initially quicker top kill of the existing foliage than dalapon alone and better translocation of the chemicals. Subsequent field trials confirmed the quicker initial effects from the mixtures, but these mixtures did not appear to have any greater effect on the regrowth than did dalapon alone. The addition of wetters improved the action of the dipyridyl herbicides, but did not have any marked effect on the other treatments.

Residual Phytotoxicity of Amitrol and Dalapon to Barley and Kale *by H. Sandford and F. R. Stovell* (*Shell Chemical Co. Ltd.*)

Chemical treatments have certain advantages over cultural methods for the eradication of couch, *Agropyron*

Photo: Dow Agrochemicals Ltd.

The creeping menace of couch. The underground rhizomes spread in all directions, and send up new aerial shoots so establishing new plants

repens, and other perennial grasses from arable land. Firstly, successful fallowing is dependent upon dry weather to kill the exposed rhizomes, whereas the action of herbicides is influenced to a much less extent by climatic conditions. Secondly, land under fallow is unproductive, whereas little or no alteration to the cropping programme is necessary where chemical methods of control are used.

Amitrol or dalapon applied to the land in the autumn can be planted with complete safety in the following spring. On heavy land, however, farmers frequently desire to sow a winter cereal shortly after the previous crop has been harvested or, alternatively, they may wish to spray in the spring prior to sowing. Thus the period of time available for the control of perennial grassy weeds is much restricted and a knowledge of the residual life of the herbicides under field conditions on different soil types from spring, summer and autumn applications is of considerable importance. Furthermore, ploughing needs to be compared with rotavation as a method of affecting rate of breakdown of chemical residues.

In a series of field experiments a study was made of the relative phytotoxicity and persistence in the soil of amitrol and dalapon under different soil and climatic conditions. It was found that, at recommended rates of application, the residual toxicity of dalapon was considerably greater to barley and kale than amitrol. For example, barley and kale planted five weeks after spraying dalapon were slightly damaged, whereas no injury occurred following amitrol treatment. Despite dry weather, the experiments also showed that rotavation was more effective than ploughing in accelerating the breakdown of residues of amitrol, though the reverse may be true of dalapon. However, it must be borne in mind that couch control with amitrol is more effective if coupled with ploughing.

Does Irrigation Pay?

Many people still regard irrigation as something practised only in arid tropical lands, but more and more farmers are beginning to realise the advantages of applying water to crops.

In order to study the possibilities, experiments were carried out at the Gleadthorpe Experimental Husbandry Farm in north Nottinghamshire, and there is little doubt that for early potatoes and grass, irrigation paid handsomely in 1960. During this year the combined April, May and June rainfall was only two-thirds of normal and it was found that by the application of 1½ in. of water the hay crop was increased by 25%, while early potatoes (lifted in July) which had been given 4 in. of water gave a yield 50% better than the unwatered crop.

Gleadthorpe is a poor sand farm in a low rainfall area and very responsive to irrigation, but out of the five seasons, 1955 to 1959, three were so wet that irrigation produced little or no gain. However, the effect of watering was so great in the two dry years that the *average* response to full watering was about 6 tons of beet per acre and 3 tons per acre of maincrop potatoes, representing a gain of some £30 per acre.

Over this period of five years the average annual application was 4 in., at which level the annual fixed cost, including interest and depreciation of the equipment, was about £2 per acre-in. To this must be added the running costs of applying 4 in. of water: at £1 per acre-in. this equals £4. £12 per acre may therefore be taken as the approximate cost of applying the quantities of water which produced these large gains in yield. These costs, however, relate to the acreage which it is possible to water at the rate of 1 in. every 10 days during the peak period of the season.

Fertilisers and Food

Dr. H. L. Richardson, head of the Agricultural Overseas Section, Billingham Division, Imperial Chemical Industries Ltd., and president of the Fertiliser Society, has been seconded to the Food and Agriculture Organisation of the United Nations in Rome for two years as Project Manager of FAO's Fertiliser Programme. This is a world-wide scheme, financed by the fertiliser industry as a contribution to the Freedom-from-Hunger Campaign, which aims at increasing food production in the under-developed countries by demonstrating the effective use of fertilisers (see WORLD CROPS, 1960, **12**, 424).

FAO plans to commence operations in the Nr. Eastern, West African and North Latin American regions immediately. The project manager, who is a New Zealander, took up his duties on 1 March and the three regional specialists will shortly be appointed.

By-products of the Rice Industry

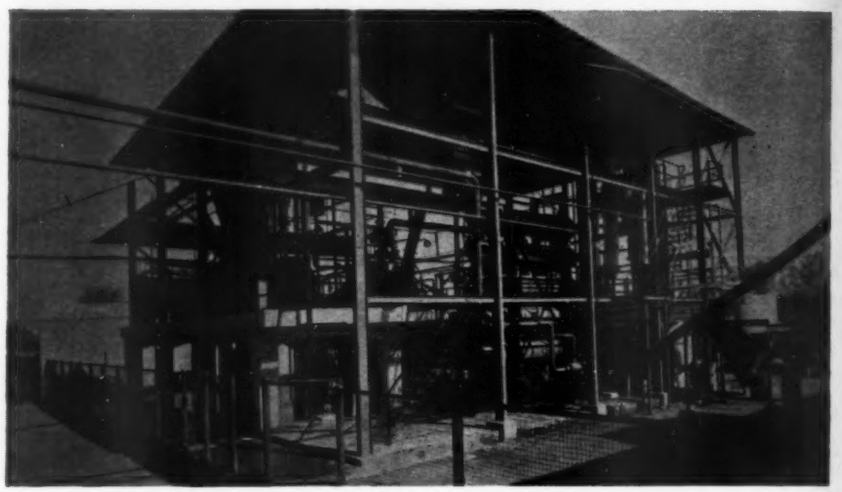
2—Extraction of Rice Bran Oil

D. H. GRIST

Rice bran oil, oil-free bran, wastes and gums are by-products of the rice industry which could be of considerable economic importance. The author here gives a brief account of what this process involves.

MECHANICAL and solvent methods of oil extraction from rice bran have been practised for many years, especially in Japan, where the annual production is about 17,000 tons a year, obtained mostly by hydraulic presses which remove only about half of the contained oil. This oil usually contains much free fatty acid, which renders it unsuitable for edible purposes.

The rice bran oil group of the U.S.D.A. Southern and Western Regional Research Laboratories, New Orleans, and the Rice Growers' Association of California have pioneered the adoption of the filtration extraction method, as used for cottonseed, to extract oil from rice bran. The success of these ventures has encouraged the commercial production of bran oil at other centres, notably in Texas and Chile. Production is also being developed in India, Japan and Formosa.



General view of the solvent extractor plant used for the production of rice bran oil

Continuous filtration process

Filtration extraction is a continuous process for the solvent extraction of oil-bearing materials. The prepared material is in contact with solvent in a mixing vessel for a sufficient time to dissolve the oil, after which a rotary vacuum filter separates the concentrated miscella from the residual meal. It has been shown that investment costs for filtration extraction mills are less than those for comparable mills of direct- and process-solvent types.

At the Regional Research Laboratories rice bran is subjected to a cooking process to eliminate very fine particles—'fines'—and thus render it more suitable for treatment. This cooked bran is solvent extracted with commercial hexane in a counter-column and the oil and meal recovered separately by the usual methods. In the California mill a batch technique has been adopted instead of continuous extraction because it eliminates the problem of 'fines', it is more flexible with regard to the tonnage processed, and the simplicity of the equipment enables the plant to be operated by less skilled personnel.

The tendency of 'fines' to become suspended in the miscella is dependent on the moisture content of the bran; fewer 'fines' pass into the miscella when bran containing about 15% moisture is extracted and this amount of moisture has no adverse effect on the yield of recovered oil.

Solvent extraction batch process

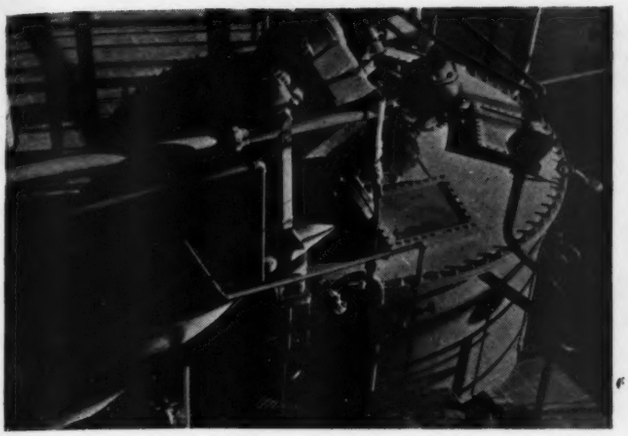
Mickus describes the operation of the batch-type solvent extraction developed in California. Commercial hexane percolates through the bran in the extractor. The resultant miscella flows to a collection header and thence to a settling chamber consisting of a tank within a tank. The miscella enters the top of the inner tank, passes out at the bottom and moves up between the inner and outer tank walls to flow to storage tanks. 'Fines' are deposited on the extractor screen and in miscella storage vessels and returned to extractors for recovery.

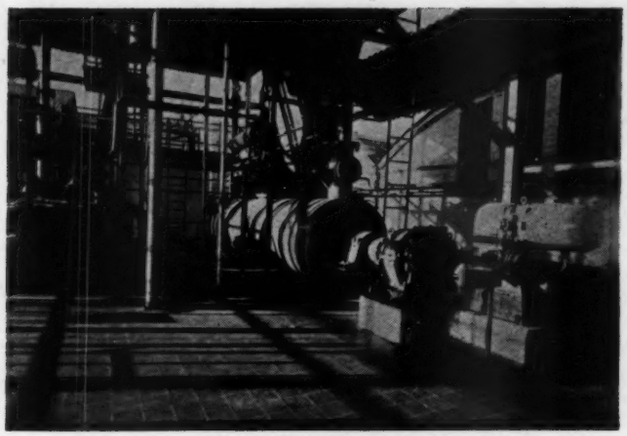
The miscella is passed to a preheater and then flows to an evaporator, where it is heated to 180°F, which vaporises about 90% of the solvent. The remaining hexane and moisture is removed in a reboiler with the additional aid of steam injected into the oil stream. The oil is then cooled in storage tanks and passed through a filter press, which removes gums, waxes, phosphatides and residual bran particles.

The extracted bran passes to steam-jacketed driers, where it is heated to 200°F to vaporise the solvent. The vapours are drawn to a scrubber, where fine particles entrapped in the stream are removed by direct water spray to prevent fouling of condenser tubes, and then drawn to the condenser and thence to decanters, where hexane-water separation is effected.

Solvents used

An objection to the use of hexane





Photos: Cia Productora Nacional de Aceites, S.A.

Left: *Close-up of the rotary horizontal vacuum filter.* Right: *View of extractor, slurry conveyor and rotary horizontal filter*

as a solvent is its inflammability; for this reason a number of alternative solvents have been tried, *e.g.* isopropyl alcohol, ethyl alcohol, trichloroethylene. The use of the last-named gave a product which was toxic to livestock. While perhaps not as efficient as hexane, alcohol has the advantage of extracting the vitamins in the syrup fraction as well as from the bran.

Extracted bran

The removal of the oil enhances the nutritive value of the bran by proportionately increasing the content of protein and carbohydrates. For this reason, and because of its better keeping qualities, extracted bran usually commands a higher price than the untreated product. Extracted bran is described as free-flowing and very light in colour and weight. It is difficult to handle and inclined to dust, which increases the loss in handling. The addition of about 3% feed-grade molasses reduces these disadvantages. Equipment is being installed in the California factory to convert the extracted bran into pellets which can be crumbled to whatever degree of fineness is desired in making mixed feed formulations.

Rice bran oil

The refined bran oil is a clear, light-coloured, odourless oil of low f.f.a., which is exceptionally stable after hydrogenation. It is acknowledged to be a superior cooking oil and has also been used as a carrier for insecticides, as sulphonated oil in textile and leather treatment, and for other industrial purposes. Possibly its greatest value will be as an anti-corrosion and rust-resistant oil. It is also anticipated that it will find several applications in the cosmetics and pharmaceutical industries.

Waxes and gums

The quality of the oil is increased when waxes and gums have been removed. At the filtration extraction plant in Chile, oil extraction is carried out at temperatures of 80-90°F and the oil is refined by the conventional method, the wax together with a small quantity of solid glycerides being separated in a 'wintering' process at 5°C before deodorising. At the Regional Research Laboratories, New Orleans, hard rice waxes of high melting points have been obtained from bran while simultaneously producing oil. The wax is reported to be largely melissyl ceritate with a melting point between 80 and 85°C.

The wax is separated by cold hexane extraction of cooked rice bran to remove the oil and hot hexane extraction to remove the wax, followed by separation of the precipitated wax by centrifuging. The resultant wax is brown in colour, but may be bleached by a mixture of hydrogen peroxide and chromium trioxide. The yield of rice wax varies from 0.22-0.31% of the original rice bran, or 1.29-1.82% of the extracted oil.

The research group in New Orleans have shown that, when refined and bleached, the wax is very similar to carnauba wax. The additional investment and operating costs to produce wax are considered reasonable.

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ACKNOWLEDGMENTS

In addition to the numerous publications consulted in the preparation of this article, the present writer is indebted to the U.S. Department of Agriculture, Agricultural Research Service; the Manager, Compania Productora Nacional de Aceites, S.A., Santiago, Chile; and to the Manager, Research and Promotion, the Rice Growers' Association of California, for information on the oil-extraction units with which they are concerned; also to the President, Wurster and Sanger Inc., chemical engineers, Chicago, for information on oil-extraction plants manufactured by them and for supplying the illustrations for the present article. Grateful acknowledgment is also made to *Food Engineering* for permission to quote from an article by Mr. R. R. Mickus, which appeared in the March number of that journal.

Drying of Cocoa Beans

An increasing quantity of cocoa beans is being shipped abroad from the Dominican Republic, principally to the U.S.A. The *Chocolatera Industrial*, the leading exporter, is extending its free drying facilities for the smaller growers.

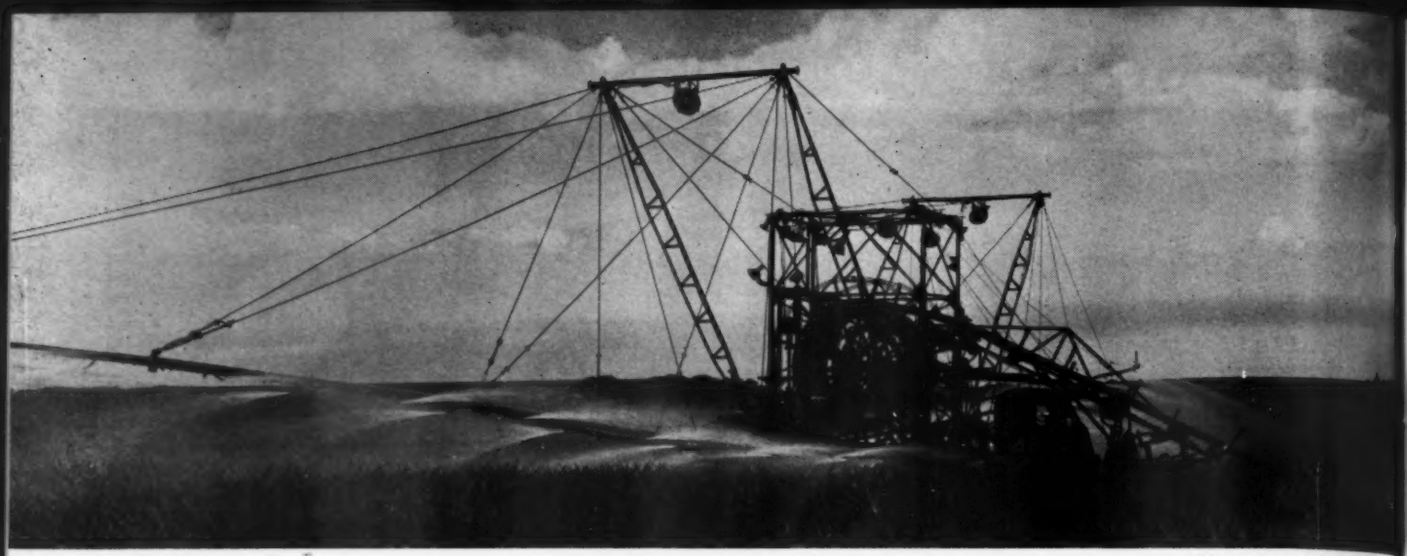

Photo: Dole Corp.

Irrigation rig used on the island of Lanai

Water for Pineapples

IN those places where pineapples are grown, the rainfall may range from as little as 15 in. up to 100 in., but optimum conditions are 45-55 in., with a marked and regular dry season and the annual precipitation evenly distributed over the rest of the year.

Drought conditions could very seriously affect production when the young suckers are developing into mature plants and also when the fruits are swelling, for droughts not only will reduce the size of the fruits, but will also affect the rate of growth of young plants in newly planted fields. Furthermore, serious outbreaks of pests are also liable to occur. Irrigation by drains, ditches and water-gates can be used in some places where the lie of the land is favourable, and experiments in rain-making have been carried out with varying degrees of success.

The leading company in Hawaii, the *Dole Corporation*, has a total of 30,000 acres under pineapples—one half on the island of Oahu and the remainder on the island of Lanai, some 60 sea miles from Honolulu, where the cannery is located. Conditions on the two islands are, however, very different, for the plantations on Lanai are generally more vulnerable to drought and it has been found necessary to resort to irrigation if the industry is to go on.

The original Lanai irrigation system was installed several years ago at a cost of over £400,000 and it is now being extended at a further cost of about £100,000—a sure indication of the confidence of the company in the effectiveness of irrigation as a means of counteracting the effects of spells of dry weather and so maintaining the plantations in profitable production.

The original shaft, which was drilled about one-third of the way up the slopes of Mt. Lanaihale in 1949, has hitherto provided the main source of water for irrigation; now it is proposed to provide further insurance against drought by tapping fresh aquifers and extending the network of permanent underground mains with a further 29,000 ft. of 10-in. piping. This will increase the supply of water from 520 million to 700 million gal. per year, which will provide water for 90% of the total planted acreage.

Water pressure is derived from the location of the surge tanks at elevations of approximately 1,800 ft. a.s.l., whilst the water is applied to the crop at elevations between 1,000 and 1,500 ft. a.s.l. The water pressure is controlled by means of portable strainer-pressure regulator stations.

Undoubtedly the most remarkable feature of the installation is the manner in which the water is applied to the crop, using five gigantic boom sprinklers which are designed to spray two blocks of pineapples at once. It is necessary to explain that the plantations are laid out with geometrical precision, following the contours so that all operations, including watering, can be done mechanically.

The plants are arranged in precise parallel lines exactly following the contour. Two of these lines, which are 2 ft. apart, constitute a bed, and 21 of these twin lines constitute a block. As the beds are set 3 ft. apart, it will be seen that a block is just over 100 ft. wide. Each block is separated from the next by a contour road along which the watering machine slowly progresses, sending a rain of water down on to the plants on both sides of the road.

The watering machine consists essentially of an enormous drum carrying 1,000 ft. of 5-in. hose, which delivers water to two 100-ft. boom sprinklers arranged on either side of a powerful lorry and carried by a rectangular cantilever boom with a system of supporting cables. One end of the plastic hose is coupled to 6- or 8-in. portable aluminium piping, which in turn is connected to one of the valves of the permanent underground 10-in. water main.

The irrigating unit is then backed along one of the contour roads, travelling as far as the hose will allow and watering the plants in passing; the operation is then carried out in reverse, the hose being picked up again with continuous watering as before. This operation has to be carried out from five to 10 times to apply from 1 to 2 in. of water to the crop.

The description of the heavy boom irrigation rigs which are used on the island of Lanai, is based on notes received from Mr. E. C. Ryman, of the Dole Pineapple Corporation.

New Publications

Sugar-cane Technology

Proceedings of the International Society of Sugar Cane Technologists. Tenth Congress, Hawaii, 3-22 May, 1959. Pp. 1174. D. van Nostrand Co. Ltd., London. 1960. Price 170s.

These proceedings, published every three years, report the progress made in the fields of growing, milling and processing of sugar-cane.

The first section covers general topics and contains 17 papers. These include a symposium of seven papers on varietal decline. Introducing the session, F. V. Abbott pointed out that yield decline of sugar-cane varieties is one of the most perplexing problems in sugar-cane agriculture. Sometimes the cause is obvious, as in the sudden failure of a variety due to a specifiable disease. The yield decline discussed here, however, is the gradual loss of vigour over some years of commercial cultivation.

In the symposium the respective roles of soil, insects, virus—especially the ratoon-stunting disease due to nematodes—were partially clarified. An illuminating paper by Mangelsdorf dealt with the genetical aspects involved, both of the sugar-cane and its associated pathogens. Although he did not exclude mutation as a contributing factor in decline, he was inclined to stress the large-scale exposure of a new variety to dynamic and diverse populations of viruses, fungi and nematodes, many of which could develop new races by mutation, or hybridisation.

The second section, factory, is covered by 35 papers, several of which dealt with crystallisation phenomena in sucrose.

The third section, agriculture, comprises 31 papers. Many of these are of interest to workers with other tropical crops and cover a wide range of topics: weed control by herbicides, manuring, foliar diagnosis, nutrition etc. One paper deals with the effects of gibberellic acid, in regard to which the author concludes that, although various kinds of response were obtained of great interest to the plant physiologist, they do not offer a practical means of increasing the production of sugar.

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The fourth section, breeding, contains 32 papers. The importance of the contributions in this section extends far beyond the sugar-cane crop itself. It is evident that ideas derived from modern genetics—even of Drosophila—are being fully exploited and that plant breeding applied to sugar-cane is well on the way to the status of a true science of genetical engineering.

Of special interest are some of the more general papers. Burton discusses the general principles of breeding vegetatively-propagated plants. Sprague outlines certain modern procedures in maize breeding which may be of possible significance to sugar-cane breeders. Recent tendencies in sugar-cane breeding—in-breeding, the use of radiation, inter-generic crossing, polycrossing — all receive attention. The methods followed in different countries are fully described. A valuable general paper on breeding methods was contributed by Mangelsdorf.

The fifth section, entomology, contains 20 papers. Several papers deal with the general aspects of the biological control of the moth borer, in which considerable success seems to have been attained. On the whole, there seems to be less emphasis on insecticides and more on the biological relationships of host and parasite, an essentially modern way of looking at insect problems.

The sixth section, pathology, comprises 26 papers. Ten of these deal with quarantine problems in relation to the possible introduction of new pests and diseases. A final communication presents a revised list of sugar-cane diseases and their world distribution.

The book is excellently edited and beautifully produced, though expensive even in these days. It provides an invaluable work of reference which will be extensively consulted.

Finally, the reviewer enjoyed the remark on page 248: 'In order to select a variety that is not damaged by typhoons, selection should be made after a typhoon'.

S. C. HARLAND

Cocoa Processing

Agricultural Engineering—The Processing of Cocoa by Terence A. Rohan. Informal Working Bulletin No. 5. Pp. 106. Illus. Food and Agricultural Organisation of the United Nations, Rome, Italy, 1960. Price not stated.

Most horticultural or agricultural men reading the title of this bulletin would imagine that it dealt with the extraction of cocoa butter from cacao and the processing of the residues into the cocoa we drink, for it is general to use the word 'cacao' (or cocoa nibs) for the raw product produced for export. In fact, the bulletin concerns the harvesting, the fermenting and the drying of cacao and a short ending concerning storage and the pests likely to attack cacao in the storage sacks.

An Englishman might be worried by the American spellings of such words as 'color' and 'flavor', but the above are the only criticisms of an excellent brochure which must have meant a tremendous amount of work to the author in studying the literature which is so freely quoted.

In the beginning, the bulletin is of great use in informing growers of the different practices in all the cacao-growing countries. Secondly, advice is gained on how to ferment with maximum aeration in order to kill the beans and obtain the right colour. Lastly, there is some further time taken during the ferment to attain the flavour, which some seem to think is caused by enzymic activity released when the bean is killed. The time it takes to ferment and obtain these colour changes and flavours is said to depend

upon the methods used and the environments in the different countries.

It is somewhat surprising to note that a high percentage of the theobromine is deposited in the shells during fermentation—almost as much as in the cotyledons themselves.

It seems that washing, claying and 'dancing', the last of which is practised in the West Indies, has no effect upon the quality of the raw product; in fact, the manufacturers would prefer good dry fermented beans of the right colour and flavour.

It is hoped that the bulletin with its excellent illustrations, suffering as it does now from its cyclostyle pages, will be published in book form for the benefit of the cacao-growing industry.

A. E. HAARER

Agronomics

Advances in Agronomy. Vol. XI. Pp. 428. Academic Press, New York and London. 1959. Price $12.

This series of volumes on agricultural problems has been prepared under the auspices of the American Society of Agronomy and is edited by A. G. Norman, of the University of Michigan. No less than 16 specialists in various branches of agriculture have contributed to the book and comprehensive lists of references are included.

About a quarter of the volume is devoted to giving an integrated picture of the soil-plant-water relationship. Agricultural scientists will read this section with great interest and gain inspiration therefrom.

There are chapters on fertiliser production, on the economics of their use and on recent developments in agricultural machinery. Though some aspects of the treatment are perhaps not strictly a part of soil and crop science, it is considered that, since the increased yields over the past two decades are largely due to more efficient machinery and to the greater use of fertilisers, both are vital problems in agriculture.

Much of the treatment is against a background of conditions in America, but one chapter deals with soils and land use in the Netherlands. The practice of including a regional survey dealing with soil resources and crop patterns in a selected area has been followed in the last few volumes of this series. Already Australia, Sweden and various belts and areas in America have been especially dealt with in this manner.

The treatment in this instance is masterly and arouses an admiration for the Hollanders, who have turned a difficult terrain into valuable agricultural land. The driving force, of course, is the problem of population and food supplies. The pattern is similar to that in other European countries—a rapidly rising population, migration from the land to the cities and marked increases in yields. Thus over the past century the population of the Netherlands has more than trebled, farm workers have fallen from 45% to 15% of the total, yet in the last 50 years, crops have doubled. What will the position be at the end of the century?

This can be read with profit and with interest by all engaged in the science of agriculture, and it should certainly have its place on all library shelves.

C. R. HARLER

Irrigation by Sprinkling

By A. Molenaar. Pp. 93. Illus. FAO Agricultural Development Paper No. 65. Rome, 1960. Price $1 or 5*s*.

In many countries water is a limiting factor in the development of available land resources. When either soil or topographical conditions are such as to preclude ditch irrigation, and whenever water supplies are limited, the application of irrigation water by sprinkling merits serious consideration.

The present publication is one of a series designed to ensure the more efficient use and control of irrigation water. The first section of the book describes pumping plants for delivering water under pressure, pipelines for conveying the water from the pump to all parts of the field, and various devices for applying the water to the soil. Many claims have been made for the sprinkler system, including uniform distribution of water and more efficient use of water with greater crop returns. Such claims can only be realised when the system is correctly designed and operated.

Accordingly, much attention has been devoted to the correct procedure to be followed in designing sprinkler systems. Other sections deal with costs, operation and maintenance, and special uses of sprinkler irrigation equipment, such as application of fertilisers and frost protection.

D. H. GRIST

Bulletins and Reports

U.K. Ministry of Agriculture. 'Cabbages, Brussels Sprouts and other Green Crops'. Bulletin No. 132. Pp. 135. Obtainable from H.M.S.O., Atlantic House, Holborn Viaduct, London, E.C.1. Price 3*s*.

University of Oxford. Agricultural Economics Research Institute. 'The Economics of Irrigation in Dry Climates' by Colin Clark. Pp. 31. Obtainable from the Agricultural Economics Research Institute, Parks Road, Oxford. Price 5*s*.

Grassland Research Institute. 'The Development and Work of the Grassland Research Institute' by William Davies. Pp. 31. Obtainable from the Grassland Research Institute, Hurley, nr. Maidenhead, Berks. Price not stated.

Empire Cotton Growing Corporation. 'Progress Report from Experiment Stations, Season 1959-60'. Reports on the Republic of the Sudan and Uganda available, price 2*s*. 6*d*. each, from the Empire Cotton Growing Corporation, 12 Chantry House, Eccleston Street, London, S.W.1.

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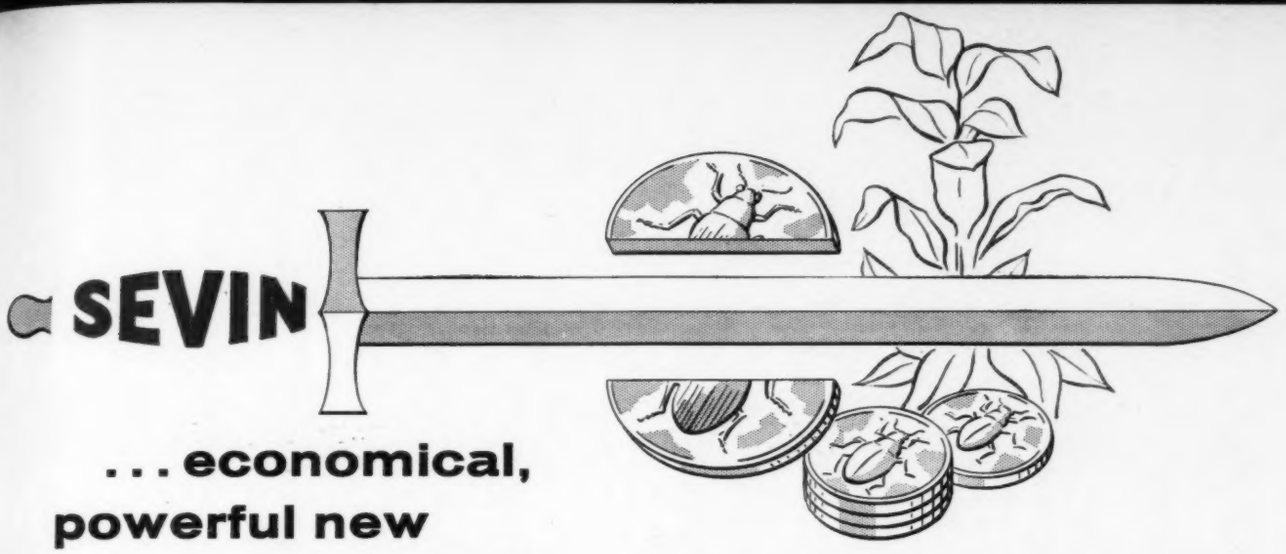
Food and Agricultural Organisation of the United Nations. 'Agricultural Engineering—Planning and Organisation of Projects for the Improvement of Hand and Animal Operated Implements'. Informal Working Bulletin (revised) No. 12. Pp. 9 (mimeographed). Obtainable from FAO, Viale delle Terme di Caracalla, Rome, Italy. Price not stated.

Harper Adams Agricultural College. 'The Control of Weeds in Maize'—Technical Bulletin No. 4. 'Maize as a Silage Crop'—Technical Bulletin No. 3. Both by M. Eddowes. Obtainable from the Harper Adams Agricultural College, Newport, Shropshire, England. Price 3*s*. 6*d*. each.

New Zealand. Annual Report of the Cawthron (Agricultural Research) Institute. Obtainable from the Institute, Nelson, New Zealand. Price not stated.

These Bulletins and Reports are available only from the addresses given above.



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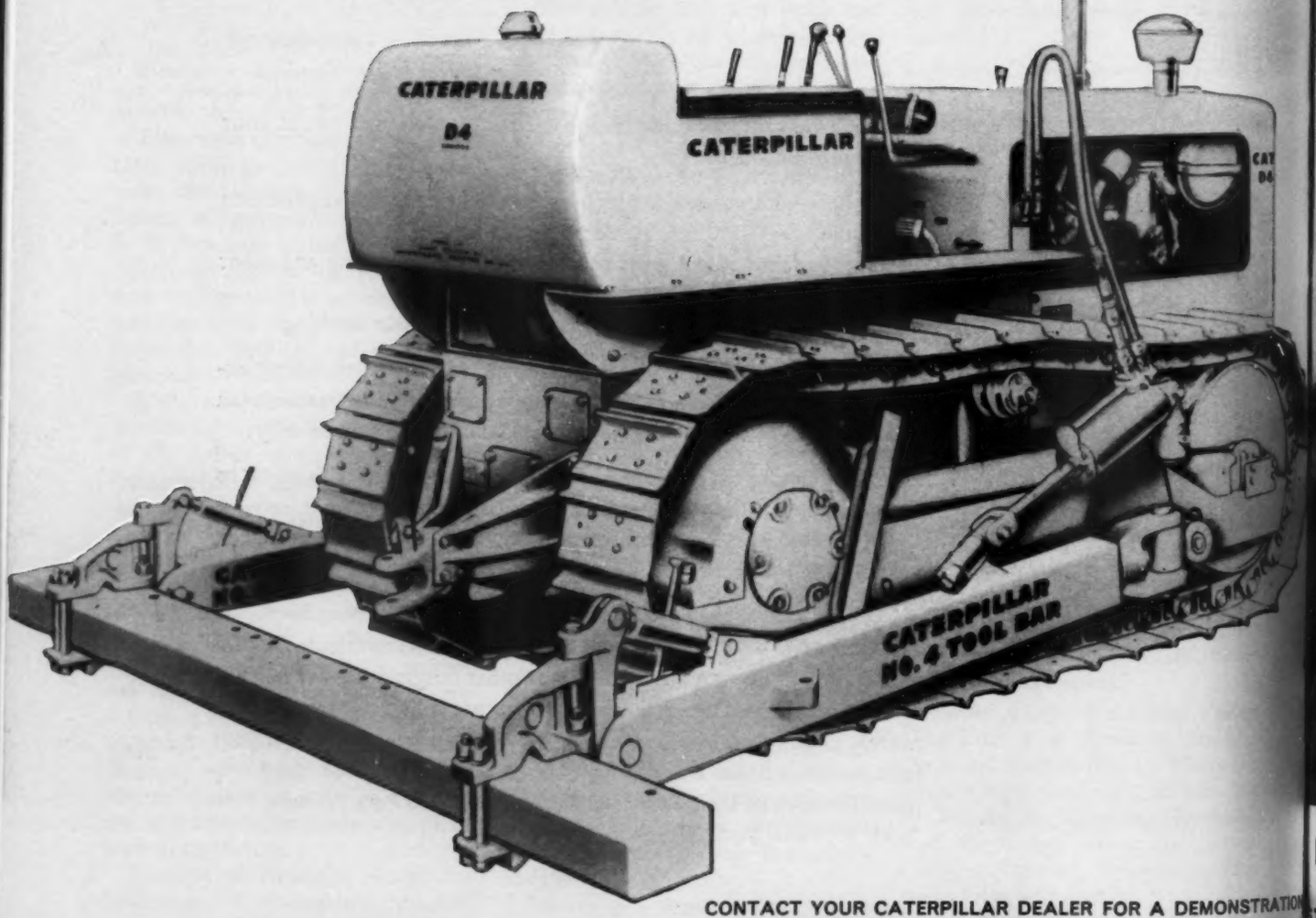

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* **COMFORT!** Advanced operating features add up to the highest operating efficiency . . . efficiency that stays high, right up to the end of the day.

ONLY THE CATERPILLAR D4C TRACTOR BRINGS YOU ALL THESE BIG ADVANTAGES PLUS THE SUPREME VERSATILITY OF CAT "SWING AROUND" TOOL BAR FARMING WITH THE SINGLE-FRAME NO. 4 TOOL BAR FOR USE WITH A FULL RANGE OF MATCHING EQUIPMENT.

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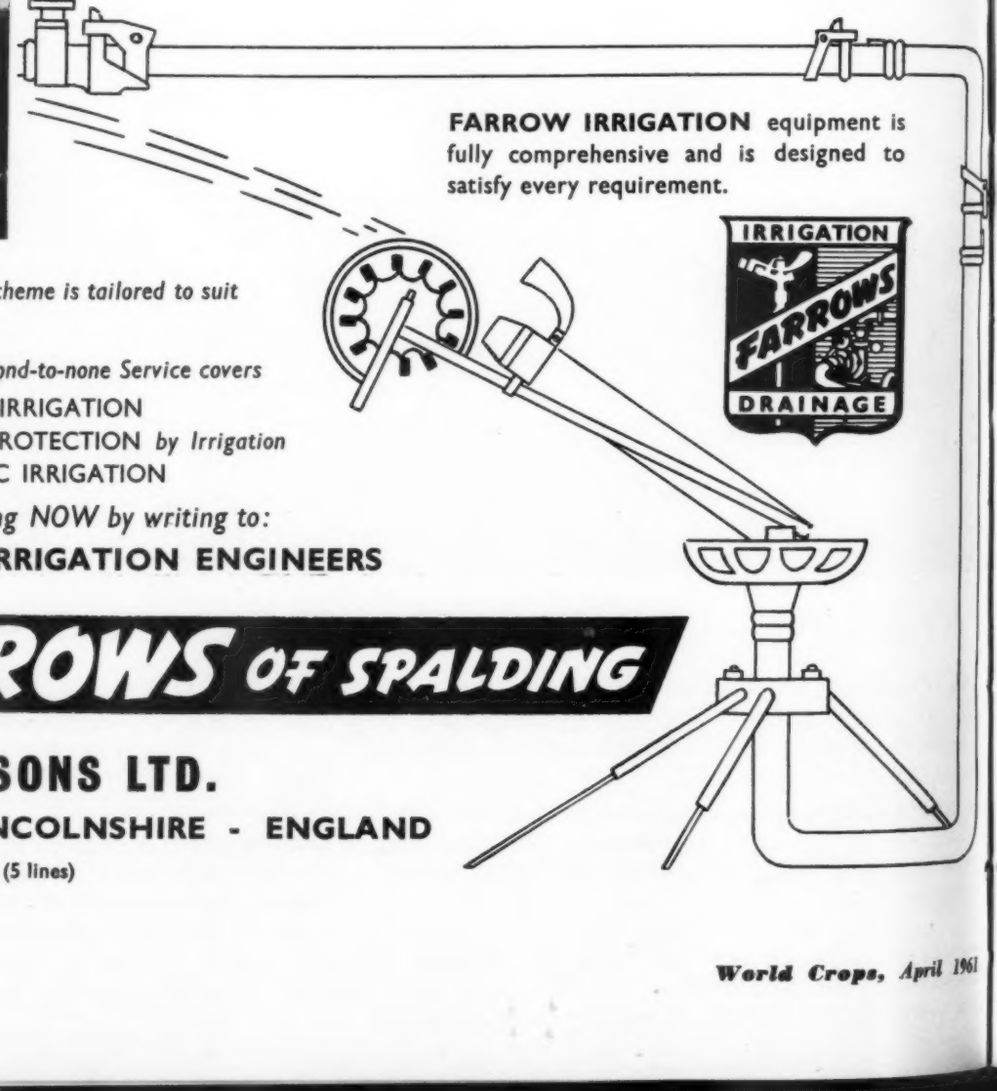

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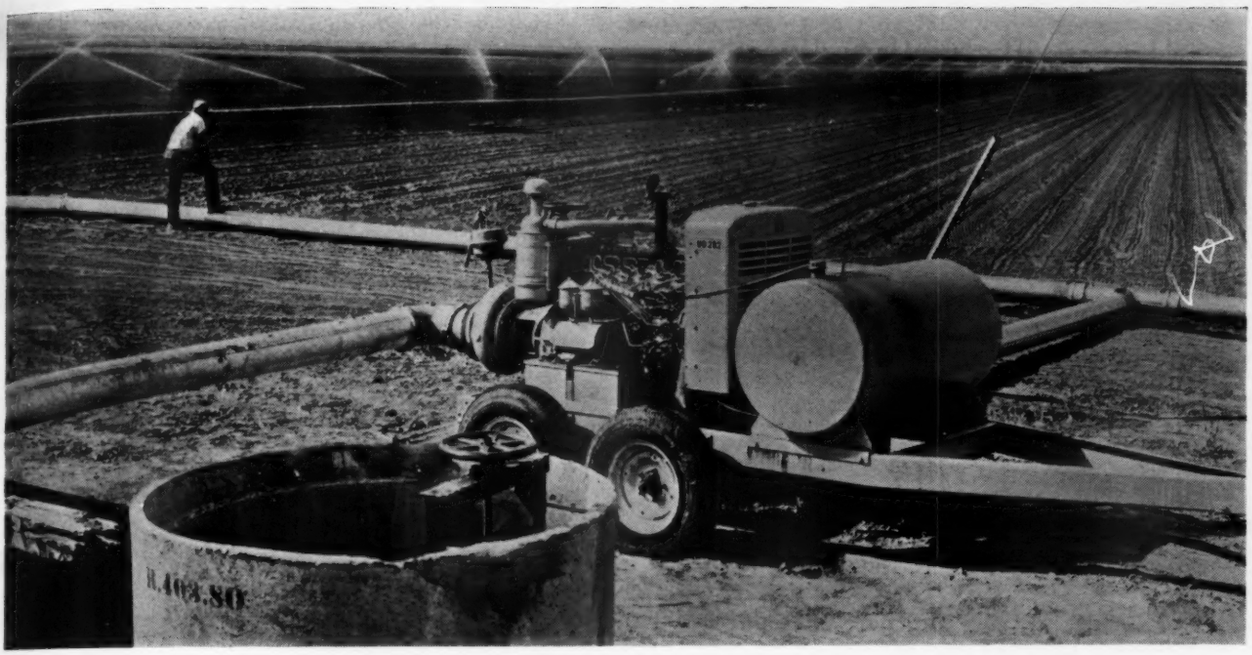


An International *UD-282 irrigation unit delivering 1,000-1,200 gal. per min. into a half mile of fixed sprayline, fitted with 300-350 nozzles, each spouting water at 3 gal. per min. and together giving 7 in. of water every 24 hours and 40 in. of water penetration. There are 16 of these units on this farm*

Machinery and Equipment

Pumping and Irrigation Equipment

Portable Pumps

Compact, lightweight, self-priming pumps which will discharge up to 7,000 gal. per hour are offered by *F. E. Myers & Bro. Co.* All the cast-iron parts of these pumps are protected against corrosion and abrasion with a 'fire-cured' epoxy resin coating. They can handle water containing a high percentage of solids and there is a quickly removable suction plate which makes it an easy matter to inspect and clean the impeller, which itself is also easily removable for replacement.

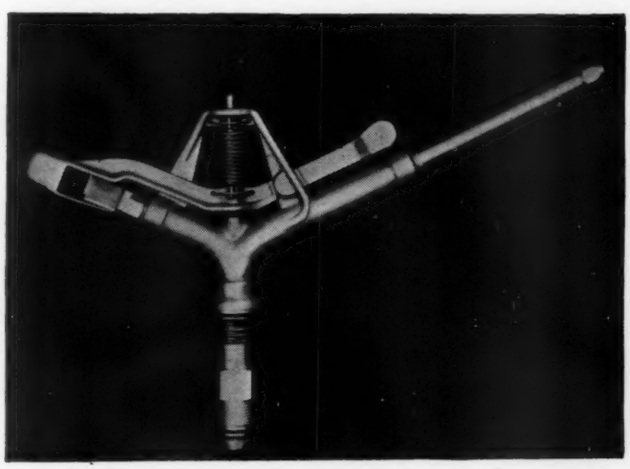
Deep-well Pumps

Once the borehole has been made, all that is needed to obtain water from a deep well is to fix a *Sumo* pump and submersible motor to its delivery pipe, lower the whole into the borehole, together with its waterproof cable, connect up to the electric power and switch on. The installation is the same whether 100 or 60,000 gal. per hour is required, and the pump can be left for long periods without attention.

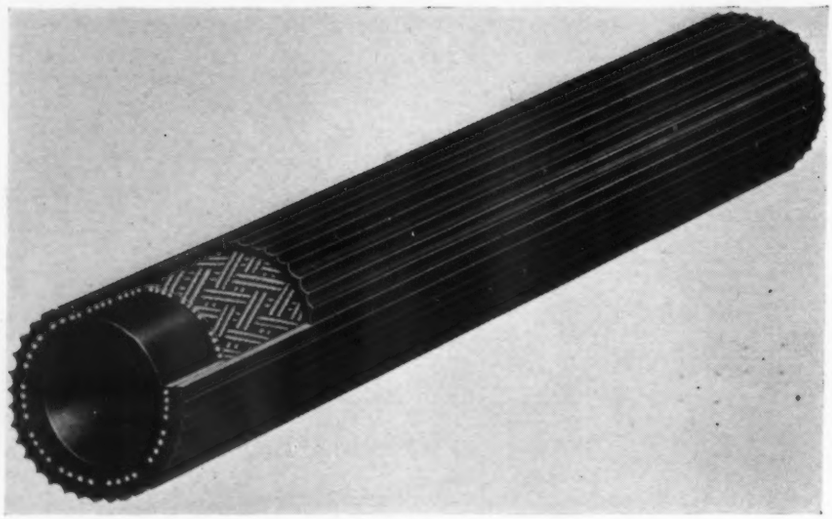
Recently the manufacturers have effected improvements in the design of the centrifugals, whereby they are able to claim that pumping losses are reduced by as much as 20% and less current is consumed. This also means that in some cases a smaller pumping unit can be used.

Planned Irrigation

The sale of the components of an irrigation system is not really completed satisfactorily until the farmer has learned how to use it correctly. It is to help to meet this need that *Wright Rain Ltd.* have published a 20-page brochure entitled 'Planned



A new sprinkler, the 'Master', shown by Wright Rain Ltd. for the first time at the Smithfield Show, has a capacity of 33-85 gal. per min. at 50-100 lb./sq. in.



Long length garden hose by Goodyear Tyre & Rubber Co.

Irrigation'. In addition to describing the company's products, the brochure deals with the watering of crops on different soils, discusses the capital and operating costs, and considers water sources, requirements and the layout of the irrigation system so as to cover the crop effectively. Copies may be obtained through our *Reader Service.*

Long-length Hose

The single-braid high-tensile rayon reinforcement hose now offered by the *Goodyear Tyre & Rubber Co. Ltd.* in long continuous lengths of 500 ft. is a useful alternative to the usual cotton reinforcement hose.

This new product has equal strength, greater flexibility and is lighter. The long hose is easy to handle and does not do damage to surfaces, since no couplings are needed. It is available in $\frac{1}{2}$-in., $\frac{5}{8}$-in. and $\frac{3}{4}$-in. sizes.

Pumping Unit

The latest *Auto Diesels* 3-in. 'Vacmaster' pumping unit is designed to handle a heavy slurry and is said to be capable of pumping against a total head of some 60 ft. It is a combination of a diaphragm pump, a self-priming centrifugal and a petrol engine, mounted together on a girder frame of rugged construction on four solid-tyred wheels. It would appear to be a useful unit for dewatering the excavations of canals, water-gates and bridges, where surplus water must be kept out of the workings.

Mobile Irrigation Systems

In the U.S.A. there has been a trend towards mechanising the movement of irrigation laterals to facilitate their transfer from one position to the next, thus simplifying the operation and saving labour. There are two systems:

The 'Power-Shift' system uses pivoting trolley wheels to carry the pipeline and the lateral is drawn lengthwise behind a tractor to the next position. The 'Poweroll' system uses high wheels, which are clamped across the lateral; a simple three-wheel, power-drive wheeled unit then rolls the whole lateral forward in one piece to the next position.

The new Auto Diesels 3-in. 'Vacmaster' pump working on site

These units, which are manufactured by *R. M. Wade & Co.*, have wheel sizes to suit different crops and conditions.

Pumps for Watering and Dewatering

Pumps ranging from 2,000 to 75,000 gal. per hour are offered by *Goodenough Pumps Ltd.* The smallest is a 1-in. self-priming motor-driven centrifugal pump, weighing only 75 lb., with a suction lift of 25 ft. and a maximum operating head of 60 ft. It would appear to be suitable for dairies, market gardens, botanical gardens, field stations and forest nurseries, or for operating sprinklers on greens and lawns.

The larger self-contained pumping units are variously mounted and variously powered: one 2-in. model is mounted on a tubular carrier and there are 2-in., 3-in. and 4-in. models, which

Assembling a 'Poweroll' wheel on the lateral line

are mounted on two-wheeled trolleys and so can be taken to various water points on estate or farm. The largest is a heavy-duty, diesel-powered set, for mounting permanently on foundation bolts or on girders, trailer or light truck; it weighs about 2,800 lb.

Water for Pastures

For heavy applications of water to pastures and to plants with sturdy leaves, such as bananas and coconuts,

there is available from *Martin-Markham Ltd.* the 'Superjet' giant rainer, with which it is possible to apply the equivalent of 1 in. of rain to about 1 acre in from 1½-2 hours, according to the jet size used. This is a single rotating unit, which is mounted on a lightweight stand of slotted metal and can be quickly rolled from point to point. Water is taken from the main at successive take-off points.

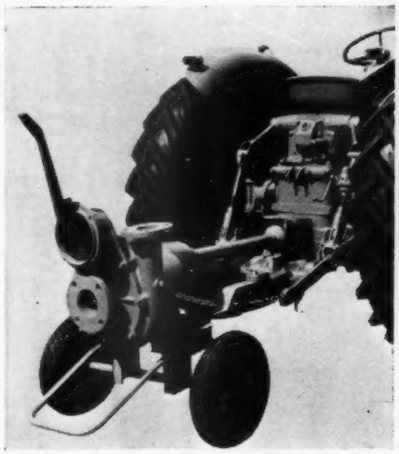
The drum on which the giant rainer is mounted is used as the reel for carrying the flexible hose which connects the unit to the take-off point on the water main. The hose is simply wound round the drum and the whole unit is then rolled to the next position

The 'Superjet' rainer is a powerful automatic rotating unit which can be moved from point to point

and unwound again, all in a matter of a few minutes. Since the rainer will cover an acre at each setting, it is possible to water large areas in a short time with the minimum of labour.

Tractor-operated Pump

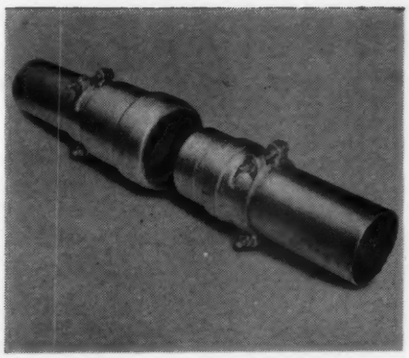
The new Alcon 'Valley Green' pump, first shown at Smithfield, is a 3-4-in. centrifugal designed specially for operation by means of a flexible driving shaft from the p.t.-o. of a standard tractor. The pump can be supplied either to fit on to the three-point linkage and so carried from point to point, or it can be mounted on a two-wheeled trolley for attachment to the drawbar of the tractor. A hand primer is fitted and connected directly to the inlet of the pump. The manufacturers, *Arthur Lyon & Co. (Engineers) Ltd.*, also offer the new Alcon 'Thames' pumps, some motorised and some self-contained in sizes from 1 in. to 5 in., designed for various agricultural purposes.



The new Alcon 'Valley Green' irrigation pump

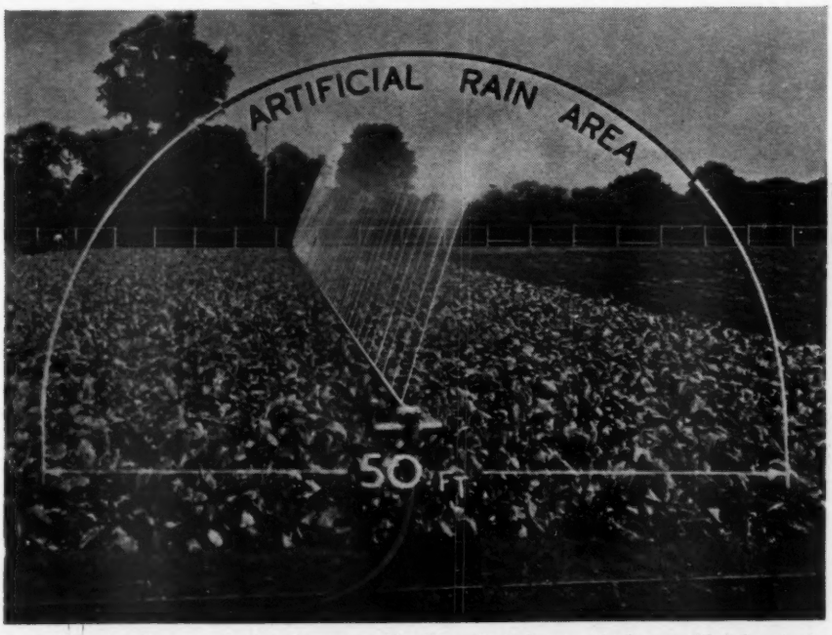
Rain for all Crops

After 35 years' experience of controlled 'natural' rainfall for crops growing under a variety of conditions in all parts of the world, *British Overhead Irrigation Ltd.* are able to advise on problems ranging from the irrigation of sugar-cane in the West Indies to the requirements of tea and other plantation crops in Africa and Asia.



The new B.O.I.L. coupling is as simple as it is effective. The sealing gasket comes into action as soon as the water enters the supply line

Their latest introduction is a new coupling for aluminium supply lines, which is as simple as it is effective. The essential seal is provided by a rubber gasket which comes into action as soon as water pressure is applied. When the water is turned off the grip of the rubber on the other pipe is released. With this design the sealing pressure is uniformly applied by the rubber ring around the circumference of the pipe it grips and when the pressure is released it is possible to separate the two pipes easily in a second or two.



B.O.I.L. oscillator spraying lines are ideally suited for producing artificial rain in tea, rubber, cocoa and coconut nurseries, and for market garden crops, where a very light and even rain is essential, so as not to cause leaf damage to delicate young plants. There is no overlapping, as the water pattern is rectangular. Another advantage is the economy of water which can result from the use of this type of equipment; e.g. with 100 yd. of spray line, the amount of water used can vary between 670 gal. per hour and 2,000 gal. per hour, depending on size of nozzle used.

Picking and Harvesting Olives

ING. DOTT. G. COPPA-ZUCCARI

Fig. 1. *The 'Manrapida' olive picker manufactured by S.A.M.A.V.*

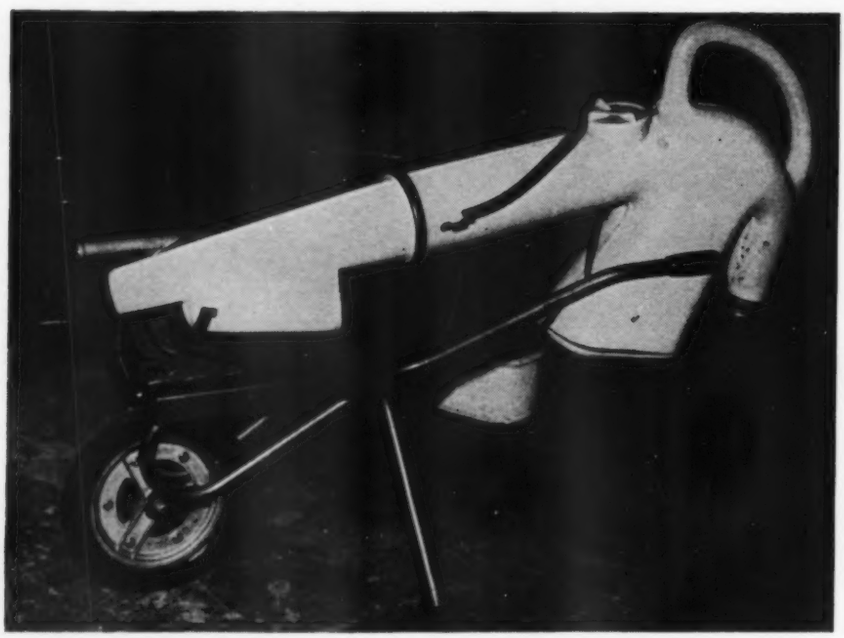
THREE olive-harvesting machines were shown and demonstrated at the 24th Levant Fair at Bari in Italy. The 'Manrapida' (Fig. 1) is a machine for picking olives, made by *S.A.M.A.V.*, of Velletri. It is essentially a pair of shears with polythene blades—one blade having teeth like a comb, the other being plain. The shears, which are at one end of a polythene tube, are opened by a long-arm extension; the instrument is then closed and moved along the branch. The severed olives drop down the plastic collection tube into a polythene bag. This implement is supplied with two tubes, respectively 2 m. and 6 m. in length.

Two firms have produced machines for picking up fallen olives. *Amenduni*, of Bari, have produced a machine (Fig. 2) which imitates the action of the fingers in picking up olives. This effect is achieved by means of two opposing rubber belts, with some 2,000 rubber fingers, which are powered by a four-stroke, 3-h.p. petrol engine. The olives are swept up into the machine, separated from foreign matter and collected in a basket at the side. It is claimed that one of these machines can do the work of 40 men.

Fig. 2. *Machine produced by Amendumi for picking fallen olives*

The third machine, by *Pieralisi*, of Jesi (Fig. 3), is like a vacuum cleaner which picks up the fruit and separates the foreign matter from the olives. When the vacuum is released the collected olives fall back on to the ground in a heap. This machine might also be suitable for collecting fallen nuts and fallen grain in a granary.

Below: *Fig. 3. The 'Olivia' vacuum machine for picking up and cleaning fallen olives*



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Reader Service

WORLD CROPS,

Leonard Hill House,

Eden Street, London, N.W.1,

England

Agricultural Chemicals and Supplies

Cleaning Choked Channels

Keeping ditches, drains, dykes, streams and irrigation canals free from reeds, which check or prevent the free flow of water and encourage the silting up of the channel, is a perennial and costly problem.

It has not been found possible to mechanise the job and hand cutting—the usual method—costs in England from £40-80 per mile, or 8*s*. a chain for a single cut. This assumes that men can be found who are willing to do this arduous work. In any case, reed cutting needs to be done once or even twice a year, and this operation has been known to stimulate growth. The possibilities of chemical weed control, therefore, need to be carefully examined.

During recent years experiments have been carried out in the Fenlands of East Anglia, where drainage and the free movement of water in the ditches and dykes are of vital importance to agriculture. In one of these trials six 30-yd. lengths of a farm drain, 6 ft. wide, which was choked with reeds, *Phragmites communis*, were sprayed with a product called 'Dowpon' (by *Dow Agrochemicals Ltd.*) in August 1958 and no regrowth of these reeds has since been reported. During 1960, however, certain broad-leaved aquatic weeds made their appearance. When sufficient leaf area was presented to enable the plants to absorb chemical, another product, 'Kuron S', was applied. 'Dowpon' was not used in this case, because it is a selective weed-killer for monocotyledons only.

A drainage channel in the Fen country of England so completely choked with reeds that it is useless as a watercourse. The operator is here seen using a three-nozzle hand lance with a low-volume tractor sprayer travelling beside him at the rate of 30 yd. per min.

A drainage channel that was treated with 'Dowpon' in September 1958. The reeds are dead and there has been no regrowth and the water now flows unimpeded. The rate of application was 25 lb. of the weedkiller in 150 gal. of water per acre, which was applied by means of a hand lance

The rates of 'Dowpon' originally applied ranged from 5½-3½ oz. per chain and cost from 3*s*. to 1*s*. 11*d*. per chain. It was apparent that these applications gave a complete control of the reeds and the 'Kuron S' was able to deal with the other types of water-weeds which appeared subsequently. 'Dowpon', incidentally, is stated to be harmless to fish and other aquatic life.

Virus Yellows and Sugar

Virus yellows is the most serious enemy to profitable sugar-beet cultivation. Its appearance is signalled by a yellowing of the outer leaves of the plant, which become brittle and may die. Its effects are sometimes underestimated, as the plant continues to put out new leaves throughout the growing season.

Crops which have been infected early in the season, however, may be reduced by as much as half, though later attacks have a lesser effect. For every week of infection up to mid-October it is estimated that the plant loses 4-5% of its potential sugar yield.

Greenfly, *Myzus persicae*, is the most important carrier or vector, though blackfly, *Aphis fabae*, also plays its part in spreading the disease. The virus which they spread can infect all members of the beet family and survive and winter in them. The most important sources from which the virus can spread to root crops in the spring are seed crops of sugar-beet, mangolds and red beet, the stecklings of which become infected in the autumn.

Certain preventive measures have been developed. All beet stecklings are now grown in isolated areas, planted under a cover crop of barley, or sprayed regularly with an insecticide. Mangold clamps ought also to be cleared by the beginning of April, because the aphids multiply rapidly in the clamps during that month.

'Metasystox', an insecticide produced by *Farbenfabriken Bayer Ag., of Germany*, which combines rapid contact action with a pronounced residual effect, has now been sprayed successfully over half a million acres of British sugar-beet during the past three seasons. One application is claimed to give a 100% kill of green- and blackflies within a few hours and keeps the crop free from aphids for 10-14 days, so delaying the spread of virus yellows and increasing the yield of sugar-beet and its sugar content. This product can be sprayed without any protective clothing being necessary, and rubber gloves and a face shield need only be worn when mixing the concentrate.

Seed Germination Indicator

The last two decades have produced great and lasting discoveries and few have been more spectacular or more beneficial than the discovery and development of agricultural chemicals and, in particular, selective weed-killers. During the same period the methods of weed control have developed and produced a science which is having a far-reaching influence throughout the world.

In presenting yet another edition of their technical handbook—'Agricultural Crop Protection Chemicals'—the publishers, *May & Baker Ltd.*, have not only made a significant contribution through the discovery and introduction of new products and in making improvements in the formulation and utilisation of their existing ones, but only about one-tenth of this invaluable monograph concerns the herbicides, insecticides and fungicides manufactured and sold by this company. The remainder of the book deals very exhaustively with the principles and techniques of spray applications.

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'Grodex'—one of the products of this company—is of particular interest to all of us in World Seed Year. This chemical, a formulation based on triphenyltetrazolium bromide, is used in 1% solution as a germination indicator. This almost colourless solution produces a clearly visible red stain on the cut surface of viable seed and so can provide an accurate estimate of the germination potential of a batch of seed.

Nitrate of Soda Sprays

According to a recent information paper issued by the *Nitrate Corporation of Chile Ltd.*, Chilean nitrate sprays for weed control in sugar-beet offers a unique combination of advantages: it destroys or severely checks most annual weeds; it will increase the yield of roots, sugar and tops through its fertilising action; and there is no financial risk in using it, even if its weed-killing power is impaired through faulty application or unfavourable weather.

Chilean nitrate of soda spray should be applied at the rate of 300 kg. or more in 800-1,000 l. of water per ha. with a spreader for whole-field spraying or at a quarter of that rate for row spraying. *Shell* 'Teepol' 1% or 'Agral 90', produced by *Plant Protection Ltd.*, are recommended as suitable spreaders or dispersing agents.

Spraying should be carried out when the plants have produced two true leaves and when the weeds are at the cotyledon or small rosette stage. It is stated that the best results are obtained when the weather remains fair and sunny for 24 hours after spraying.

Uses of Polyethylene Film

Current applications of polyethylene film in agriculture and horticulture are described in an illustrated booklet recently published by *Bakelite Ltd.* These include the inner lining of plant houses, its use as a protective cover in grafting and rooting operations, as a lining for canals and small water reservoirs to prevent seepage, and as a mulching material to accelerate plant growth and for weed control. It also makes a most attractive packaging material for horticultural produce. The booklet is obtainable through our Reader Service.

Chemicals for Tea

For some years now chemicals have played a growing part in protecting tea from pests and diseases. In particular, copper fungicides have been used successfully for more than a decade to combat the deadly blister blight, whilst acaricides have long been a necessity to control mites. Chemical weed control has not so far been practised, but a recent discovery—'Simazine 50W'—has opened up prospects of the selective control of grasses and other weeds in tea.

Fisons Pest Control Ltd. have produced a useful booklet which summarises information on products being developed for use on tea, and the folder is designed to allow supplements to be added from time to time as more information becomes available in this fast-growing field of crop protection. Copies of this brochure can be obtained through our Reader Service.

'*Agricultural Crop Protection Chemicals*,' pp. 151, profusely illus., obtainable through our Reader Service.

World Crop Reports

INTERNATIONAL REPORTS

Tobacco

World tobacco production in 1960 is now placed at a record 8,823 million lb., 4% more than the 1959 world harvest of 8,499 million lb. and 2% above the 8,681 million in 1956, the second largest crop on record.

Major production increases this year were in the U.S.A., Canada, the Federation of Rhodesia and Nyasaland, Brazil, India and Turkey. Crops in the Rhodesian Federation and Turkey reached record levels. Larger yields per acre in the U.S.A. resulted in a crop of 1,952 million lb., compared with 1,797 million in 1959.

Smaller increases were recorded for the Dominican Republic, Argentina and the Philippine Republic. These gains more than offset drops in European countries, particularly in West Germany, where the crop was affected by blue mould. Unfavourable weather reduced the crops in Greece and Italy. World record production of flue-cured tobacco at 3,265 million lb. in 1960 was 6% above the previous record of 3,071 million in 1956.

North America: Production in North America in 1960 totalled 2,472 million lb., about 13% above the 2,196 million harvested in 1959. U.S. production in 1960 was 1,952 million lb., 9% above 1959, but 11% below the 1950-54 average. Flue-cured tobacco accounts for most of the increase in the U.S.A., with production of this kind of tobacco at 1,242 million lb. in 1960, or about 15% larger than 1959. Canada produced 197 million lb. of tobacco in 1960, 16% larger than the 1959 harvest of 170 million lb. Crops in most other areas of North America did not vary much in 1960 from those of the previous year.

South America: Production in South America in 1960 was 544 million lb., 13% larger than the harvest of 482 million in 1959. Brazil's crop of 324 million lb. in 1960 was 17% above the 1959 crop. Smaller increases are reported for Argentina, Venezuela and Paraguay.

Europe: Production in Western Europe in 1960 declined to 515 million lb. from 593 million lb. in 1959, chiefly because of drops in the Greek and West German harvests and lesser declines in France and Italy. The Greek and West German crops declined by 38 million lb. and 26 million respectively. The 1960 harvest in Eastern Europe, excluding that of the U.S.S.R., was 542 million lb., down 9% from 1959, mainly attributable to a poor crop in Yugoslavia caused by drought.

Photo: Shell

Spraying tobacco plants in Venezuela

Africa: A record African tobacco production in 1960, at 428 million lb., was less than 1% larger than the 426 million in 1959. The major increase was in the Federation of Rhodesia and Nyasaland, where the 1960 yield of 256 million lb. was a record crop. Flue-cured accounted for most of the Federation's increase in 1960. Production in other areas, except the Union of South Africa, remained about the same.

Asia: Asian tobacco production totalled 3,860 million lb. in 1960, compared with 3,771 million in 1959. Substantial increases in Turkey, India and the Philippines more than offset declines in Pakistan, Japan, Indonesia and Thailand.

Oceania: The Australian crop of 20 million lb., which was 6.4 million lb. larger than in 1959, raised Oceania's total production from 19.6 million lb. in 1959 to 27.4 million in 1960.

Pepper

World pepper production during 1960, forecast at 191.2 million lb., would be the highest during the post-war era and exceed for the first time the pre-war average of 184.2 million lb. Indonesia, India and Sarawak provided the bulk of the world's pepper, smaller quantities being produced in Ceylon, Indo-China, Malaya and the Malagasy Republic. Brazil, the newest producing country, is increasing its output.

Indonesian production during 1960 is forecast at 77 million lb., slightly higher than the 1959 total.

Sarawak is expected to produce about 21 million lb. of pepper during 1960, compared with 18.7 million lb. during 1959.

India produces only black pepper and production is forecast at 62 million lb., slightly higher than the previous year.

The domestic market accounts for practically all of the pepper produced in *Ceylon*. Production during 1960 is estimated at 14 million lb.

Brazil's output during 1960 is forecast at 10 million lb., although this may prove to be a conservative estimate.

REGIONAL REPORTS

Spain

Spain's *cotton* crop for the 1960-61 season (August-July) is now estimated at 340,000 bales (500 lb. gross)—14% larger than the 1959-60 crop of 298,000 bales and 66% above the average annual production of 205,000 bales in the past five seasons. It is possible, however, that heavy rains throughout Spain may reduce production from the above estimate.

About 27,500 bales or 8% of this year's crop is extra long-staple cotton. The larger production this season is attributed mainly to an increase in acreage, mostly in the unirrigated area,

from 556,000 acres in 1959-60 to 640,000 acres this season.

Greece

The Greek Government recently announced that the *cotton* subsidy in the form of direct payments to cotton producers would be continued in 1961-62. Other types of Government assistance designed to augment production include expansion of irrigation facilities, variety limitation and improvement, more effective insect control and the financing of cotton exports.

As a result cotton acreage in Greece rose from 325,000 acres in 1959-60 to a record of 411,000 acres in 1960-61. Acreage during the 1950-54 period averaged about 219,000 acres.

Production in 1960-61, estimated at 331,000 bales (500 lb. gross), is a record, exceeding the 1959-60 crop by 69,000 bales, or 26%. About two-thirds of the cotton acreage is now irrigated.

It is planned to increase the area planted to *tobacco* in 1961. The acreage to be cultivated next year will be 267,000 acres, compared with actual plantings of 234,000 acres in 1960.

The Government's policy has been to hold tobacco acreage at around 247,000 acres. The 1960 plantings, however, were well below this level, mainly due to unfavourable weather during the planting season. As a result the 1960 crop is estimated at 141 million lb., of which about 128 million will be marketable leaf. In comparison the 1959 crop of marketable tobacco was estimated at about 170 million lb.

Italy

Italy's *rice* production in 1960, officially estimated at 640,000 m. tons (1,400 million lb.) of rough rice, is 10% below 1959 and 13% less than in 1958. Average output in 1950-54 was 838,000 tons.

Rice acreage decreased from 336,000 acres in 1959 to 311,000 acres. The reduction was nearly as large as that planned by the Ente Nazionale Risi in order to decrease stocks. Acreage in high-quality (medium to long grain) rice was reduced by 20%.

This type, being relatively high in price, has been difficult to export. One solution towards its disposal has been to increase domestic consumption and to decrease consumption of short-grain varieties.

The 1960 crop of *tobacco* is estimated at about 190 million lb.—about 5% less than the 199 million harvested last year. Although there was some damage from blue mould, crops of both flue-cured and burley were larger than in 1959. Flue-cured, at 32 million lb., was up 22%; burley, at 39 million lb., was up 6%.

Drops in production of fire-cured, Maryland and Oriental tobaccos more than offset increases in flue-cured and burley. Percentage drops were: fire-cured, 18%; Maryland, 19%; and Oriental, 15%.

Ghana

Indications are that Ghana's 1960-61 *cocoa* crop will be larger than the 1959-60 crop, which was a record harvest of nearly 653 million lb.

The capsid spray programme is mainly responsible for the larger crop this season. It has not only greatly increased the survival rate of new plantings and permitted earlier bearing, but has also increased the yield of mature trees. Other factors contributing to increased production are: intensification of swollen-shoot control measures, favourable weather, effective extension work in training cocoa farmers and the coming into bearing of new, improved plantings.

Mexico

Mexico's 1960-61 *cotton* crop, currently estimated at 1.9 million bales (500 lb. gross), is 12% larger than last season's crop of 1.7 million bales, but 19% smaller than the record 1958-59 crop of 2.3 million bales. Some trade sources estimate this year's crop may be over 2 million bales.

Plantings this season totalled about 2.2 million acres—up 23% from 1.8 million acres in the previous season and near the annual average of 2.3 million acres during the past five years.

Following a substantial reduction in 1959-60, acreage and production increased this season in most major cotton-producing areas. However, early estimates of the 1960-61 crop have been reduced in Matamoros and west coast regions because of unfavourable weather. In the Matamoros region early-season drought hurt the rain-grown crop, while heavy rains and cold weather later in the season lowered yields in irrigated areas. The larger acreage in 1960-61 is attributed mainly to an easing of production credit and the fact that cotton prices were higher at planting time than those during the 1959 harvest season.

Pakistan

Seeding of Pakistan's 1961 *wheat* crop was delayed because of inadequate soil moisture. Rainfall was scanty and held up preparation of the land for seeding and the dry soil prevented proper germination in the already seeded areas.

Wheat acreage in 1960 was a record 12.2 million acres. This was 18% above the 1950-54 average of 10.4 million acres. Wheat production was also high at 146 million bushels. Despite the high level of production, imports for 1960 are expected to total 50 million bushels.

Tasmania

Hops production in Tasmania, where most of Australia's hops are grown, is expected to be greatly reduced in 1961 and 1962 because of heavy flood damage in late April. Since picking in Tasmania takes place in late March and early April, the flood probably did not hurt the 1960 crop much.

The flood destroyed hop poles, frames and trellises, damaged windbreaks and washed away top soil from 250-300 acres of Tasmania's total of 1,446 acres under hops. Many growers cannot afford the cost of rehabilitation and the Commonwealth Government has been asked to provide non-interest-bearing loans for that purpose.

Because of earlier damage by hail and dry weather, Tasmania's 1960 crop was estimated late in May at only 2.4 million lb., compared with 3.4 million lb. in 1959. Total Australian production in 1960 is estimated at 3.1 million lb., about 30% less than the 1959 record of 4.1 million lb.

Kenya

Sisal production in Kenya, the fourth largest producing country, continued to rise in the first six months of 1960. Output reached 65.6 million lb., compared with 56 million in the corresponding period of 1959. Production in June reached 11.7 million lb., the highest monthly total in the first half of 1960.

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